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A., Feilding, 9th Earl of

Beet sugar as a British
industry

[London]

[1912]

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AS A

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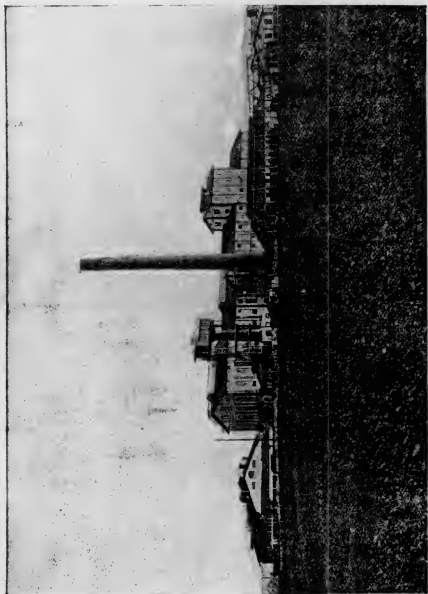
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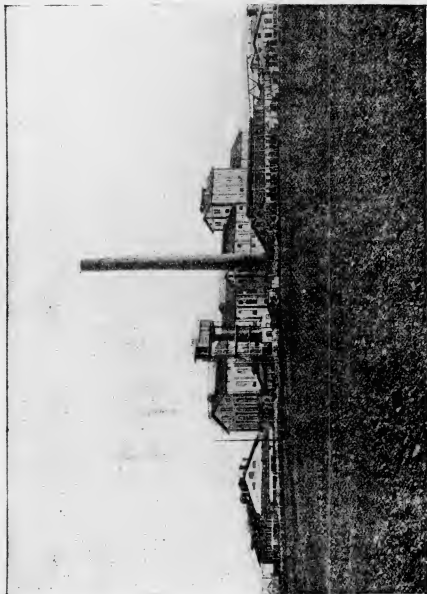


GENERAL VIEW OF THE BARANYAVAR-PELMONOSTOR (SOUTH HUNGARY)
SUGAR FACTORY, working 1,000 Tons of Beet per 24 Hours.
Erected and equipped in 1911 by The Breitfeld-Danek Engineering Company, Prague.

June 1912.

INDEX.

	PAGES
BEET SUGAR AS A BRITISH INDUSTRY .. By THE EARL OF DENBIGH	1-16
A GUIDE TO THE CULTIVATION OF SUGAR-BEET By R. N. DOWLING	17-25
CO-OPERATIVE SUGAR FACTORY IN HOLLAND .. By "HOME COUNTIES"	26-27
PRODUCTION OF BEET SUGAR IN A CONTINENTAL FACTORY By R. N. DOWLING	28-34
REPORT OF EXPERIMENTS ON FEEDING SUGAR- BEET SLICES TO FATTENING CATTLE AND MILCH COWS By R. N. DOWLING	35-54



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ILLUSTRATIONS.

GENERAL VIEW OF THE BARANYAVAR-PELMONOSTOR
SUGAR FACTORY.

CO-OPERATIVE SUGAR FACTORY AT DINTELOORD,
HOLLAND.

GENERAL VIEW OF A FACTORY AS SEEN FROM VACUUM
PANS.

EVAPORATING PLANT

VIEW OF ENGINE ROOM

BET SLICE DRYERS

VACUUM PANS

BEET SUGAR

AS A BRITISH INDUSTRY.

The following article, which appeared in "The National Review" for August, 1911, is reprinted by permission of the Editor, and has since been revised by Lord Denbigh.

The agitation in favour of establishing the sugar-beet industry in the British Isles has now reached a stage at which it is desirable to give as many definite facts as possible and avoid generalities. I am as much opposed to over-statements in favour of the industry as to the many quite absurd arguments circulating against it, and which I fear the space at my disposal will not allow me to criticise as fully as I desire. I make no apology for inviting attention to this question, because, when a subject can be regarded as of importance from its economical, sociological, scientific, political, agricultural, and commercial aspects, it may safely be said to be one of more than ordinary interest. Now, the sugar industry has played a great part in many countries in connection with all these points, but it is to chemists and scientists that the world is largely indebted for its wonderful development. It would be hard to find in the whole range of human progress a more striking example of the enormous benefits arising from the triple alliance of Science, Industry, and Agriculture.

It is surely a most remarkable fact that such agricultural scientists as Messrs. Rabbethge, of Klein Wanzleben, and others should have been able, by careful cultivation and selection, to produce a beet-root containing 15, 16, 17, and even in some cases over 20 per cent. of sugar, when it is remembered that the sugar contents of the original primitive wild beet are only about 2 per cent.

If the world owes much to chemists for cheap sugar, the debt to the engineering profession is scarcely less great. It is only by comparing the rudimentary processes by which sugar was extracted from the beet at considerable cost, to those in use in a modern factory, that this can be realised. A problem of great difficulty had to be resolved by the chemist and engineer. We here have vast quantities of a perishable article—tens of thousands of tons (some of the large factories on the Continent treat as much as three thousand tons of beet a day)—arriving at the factory, and having to be handled in a very short time. A beet factory only works from sixty to, at the outside, one hundred days a year, and the roots arrive by wagons, rail, or boat, in an unending stream, whilst they cannot be stored for long. The margin of profit is

very small when prices are normal, and the mere rapid handling of this vast quantity of material is a serious problem, so that for economical and other reasons the process of manufacture must be a continuous one. From the time the beets are shot into the yard, on or alongside the flumes by which they are carried to the washing machines, thence to the cutting machines, automatically elevated, weighed, treated in diffusion batteries, limed, crystallised, &c., either as raw 88 per cent. or refined granulated sugar, there must be no stop in the process of manufacture. A modern beet factory, with its many boilers, miles of piping, hundreds of valves, pumps, batteries of diffusers, defecators, filters, evaporators, centrifugals, &c., is, indeed, an engineering triumph.

Although in an article dealing with this subject it might be reasonable to expect much technical detail, I may state at once that I am not going into details of technical manufacture, for I don't profess to have the necessary expert knowledge. I am merely a humble outsider, much interested in land and agriculture, and in the great rural problem. I have been also much struck by the enormous influence which the sugar industry has had in the scientific agricultural development of other countries, and the absolute ignorance of the subject prevailing amongst all classes here, with the exception of those actually concerned in the sugar trade, and a few others.

Let us first of all consider some general aspects of the question. Sugar is an important article of food—in fact, it may be said to have become an absolute necessity in these days. The annexed tables give our imports for the last three years. It should be noted that 1911 was an abnormal year by reason of the remarkable drought, which affected the whole of the Continent except Russia. Though the sugar percentage of the roots was high, the European crop came out at about 1,800,000 tons less than that of 1910, whilst prices went as high as 18s 6d per cwt. 1910 was also a year of extraordinary prices, which affected our imports.

TOTAL IMPORTS OF SUGAR AND MOLASSES.

1909.		TONS.	VALUE.
1,913,968	.. ..	£22,373,683	

Of this, Beet Sugar and Molasses from the Continent of Europe, represented:—

		TONS.	VALUE.
1,621,508	.. ..	£19,137,898	

The bulk of this Beet Sugar came from two countries: 789,224 tons, value £9,641,518 from Germany; and 333,408 tons, value £4,251,650 from Austria-Hungary.

UNREFINED CANE SUGAR.

		TONS.	VALUE.
292,459	.. ..	£3,232,785	
of which, from the British Colonies, only		85,266	£1,002,147

1910		TONS.	VALUE.
1,884,681	.. ..	£25,282,484	

Of this, Beet Sugar and Molasses from the Continent of Europe represented:—

		TONS.	VALUE.
1,322,515	.. ..	£17,593,139	

The bulk of this Beet Sugar came from two countries: 563,843 tons, value £7,724,418, from Germany; and 257,037 tons, value £3,818,787, from Austria-Hungary.

UNREFINED CANE SUGAR.

		TONS.	VALUE.
562,165	.. ..	£7,689,350	
of which, from the British Colonies, only		130,139	£1,843,088

1911.		TONS.	VALUE.
2,068,327	.. ..	£27,481,548	

Of this, Beet Sugar and Molasses from the Continent of Europe represented:—

		TONS.	VALUE.
1,606,288	.. ..	£20,902,526	

The bulk of this Beet Sugar came from two countries: 758,759 tons, value £9,601,463, from Germany; and 248,162 tons, value £3,480,325, from Austria-Hungary.

UNREFINED CANE SUGAR.

		TONS.	VALUE.
462,040	.. ..	£6,579,022	
of which, from the British Colonies, only		178,666	£2,562,712.

It will thus be seen that we are, to a great extent, dependent for our sugar supplies on the continental beet industry—much more so than most people imagine. It is surprising to find how many educated people there are who, until recently, had never heard that sugar was made from beet, whilst others thought that all sugar consumed in England was made from cane.* Being thus dependent on the Continent, it is easy to imagine how prices might at once rise against us to an alarming extent in the event of any widespread Continental commotion.

It is difficult to understand why our great confectionery manufacturers, who are wholly dependent on foreign sugar for their raw material, should be so concerned about the present import duties on sugar, amounting to one-fifth of a penny per lb., and should apparently pay so little attention to the possibility of developing the home industry which might provide large quantities of raw material at their own doors.

The sugar industry is one which employs a great deal of labour, and in these days, when the continental armies absorb practically the whole of the male population below a certain age, a general conflagration could not help interfering in a disastrous way with the supplies of sugar. According to the report of the Royal Commission on the

* The idea which one so often hears given expression to, that beet sugar is not so sweet as that made from cane, is a pure fallacy. Chemists say that it is not possible, when once sugar is refined, to detect any analytical difference between cane and beet, and the difference observable between the sugar generally found abroad and that used in England is purely one of manufacture.

Supply of Food and Raw Material in Time of War, the average stock of sugar in this country is only equal to three months' supply. Anything, therefore, which can render us and our great sugar-consuming industries less dependent on continental supplies must be worthy of our earnest consideration.

We have next to consider the agricultural position in England. During the last fifty years some 4,000,000 acres of land that formerly grew corn have been laid down or allowed to go down in grass, very often of an inferior description. Whereas some eighty years ago we grew corn sufficient to feed 23,600,000 out of a total population of 24,600,000, or 96 per cent. (1831-5), in 1901-5 the proportion had sunk to 10.6 per cent., or 4,500,000, out of a total population of 42,400,000; in fact, more corn land has gone out of cultivation than the entire area which now grows wheat in these islands. The result of this has been that we are to an alarming extent dependent upon the foreigner for our food. Our agricultural population has diminished by one-half, and we are constantly hearing complaints as to the inefficient cultivation of the land and the importance of doing all we can to prevent people from continuing to migrate into the urban industrial centres. What is urgently needed is any industrial development closely connected with, and dependent on, agriculture, and providing plenty of employment in the rural districts at wages which will tend to keep the people there instead of flocking into the towns. Anything, therefore, which will do this, and will, at the same time, encourage the development of what is known as scientific and intensive farming, anything which will increase the fertility of the land and bring grass land once more under the plough, cannot fail to be of importance to this country. If the sugar industry has had the effect of producing these results in other countries, it is surely desirable to see if it could not be made to produce similar results in the British Islands. Some interesting figures were given in an article by Mr. Saxon Mills, which appeared in the *Nineteenth Century*, as showing the advance Germany has made since 1880.

	Rye.	Wheat.	Tons. Oats.	Potatoes.	Sugar.	Hay.
1880 ...	4,952,325	2,345,278	4,228,128	19,466,242	415,000	19,563,388
1908 ...	10,736,874	3,767,767	7,094,833	46,342,726	2,139,000	27,076,097
				Cattle.	Pigs.	
1883 ...	...	...	...	15,766,702	9,206,195	
1907 ...	...	...	...	20,539,544	22,146,532	

Exports of manufactured goods :—

1880 ...	£83,500,000
1907 ...	£231,900,000

As a contrast, with the single exception of oats, all other crops in the United Kingdom since 1885 show a decline; some of them a considerable decline. As stated, the wheat produced at home only suffices for 10.6 per cent. of our population. Taking corn crops as a whole, the area cultivated has declined by nearly 40 per cent. in the last thirty years, and during the same period there has been a decline of one-sixth in the area under green crops. Again, unemployment in this country has become a matter demanding the close attention of the legislature, and the expenditure of large sums provided by the taxpayer. Surely it is, therefore, of interest to neglect no opportunity of developing, on sound lines, any industry which does not exist amongst us at the present time, and which would give employment to our people when it is so badly wanted. One of the most striking facts connected with the sugar-beet cultivation abroad is the way in which it has improved poor land.

In many parts of Germany, especially in Silesia, thousands of acres of what used to be poor sandy soil, hardly able to grow anything, are now good agricultural land, entirely owing to the scientific and careful cultivation of sugar-beet over many years.

In an interesting paper recently read by Mr. Christopher Turnor on "England's Food Supply," after dealing with figures similar to those already given, and showing how we have fallen off in our production of wheat, he points out that the average yield of land in this country is only about £4 per acre. He says :—

"This is altogether too low, and I have no hesitation in saying that this yield of £4 could, by the adoption of proper methods and by proper education of the huge class of small farmers, be turned into an average yield of £8 per acre.

"It is the poor class of land which has suffered the most from the agricultural depression. Good land has always maintained, sometimes even more than maintained, its standard of production. The landowner possessing good land has always been able to choose good farmers. In suitable districts of England market-gardening and fruit-growing have prodigiously increased the production of the soil. But the decline in the poor land has more than counterbalanced the increase in the rich land. I am convinced that the solution of the problem lies in bringing our poorer soil not only back to its former condition of fertility, but to a state of fertility of which the English farmer is at present entirely ignorant.

"Every day you hear agriculturists say, 'Oh! you can do that on rich land; but what about the poor land?' There is not in this country the faintest conception of what can be done with the poorer classes of land, and I am forced to look to Flanders for an example. Flanders, in former years, was agriculturally the poorest part of Belgium; its soil was wretched. To-day its output per acre is, perhaps, higher than a similar area in any other portion of the earth. The yield per acre being very nearly £20; the result of scientific treatment and of a sufficiency of capital.

"Hand in hand with the development of the poorer soil must go the education of that large mass of small farmers. We have in each county farmers who are, perhaps, the finest farmers in the world. It is these farmers who have won for England in the past its great reputation. But these farmers are few in number, and it is not the 'show' farmers who set the standard; it is the mass of average men. There are about 508,000 farmers in Great Britain. Of those, not less than 350,000 are farming 100 acres and under. These are the men who must be reached by Education, Organisation and Co-operation. In the past such education as has been provided has been in the main for the class of the large farmers. We have thought of the 'show' man and neglected the mass of small farmers. A very common objection to what I am advocating is: 'This is all very well; we agree with what you are saying; but it is useless to make effort in these various directions while the price for agricultural produce is so low.' My answer to this is that Denmark has organised her agricultural industry and made it one of the wonders of the world with the prices of farm produce over the past twenty years averaging from 10 to 20 per cent. lower than those in this country. Indeed, it is only when prices are low that the pressing need for organisation is felt. To develop these areas of poor land the essentials are Education, Co-operation, and Access to Capital."

I firmly believe that nothing would teach our farmers to think, to improve their methods, their farming and consequently their farming returns, as much as a successful establishment of the beet industry.

Such are some of the broad aspects to which I would invite attention for the purpose of considering whether it would not be highly advantageous from these points of view if the beet-sugar industry could be established in this country, whether the difficulties in the way cannot be overcome, and if not, why not?

Let us first see what has been done abroad. Two years ago there were 1,400 beet sugar factories in the world, of which Germany had 354, Austria-Hungary 222, France 252, Russia 277, Belgium 77, Holland 27, Sweden 21, Denmark 8, Italy 35, Spain 32, North America 70, and Canada 6, whilst Great Britain was, and is, represented by the depressing word *nil*.

The above list shows how widespread is the sugar industry, and under what diversity of climates it flourishes. When this industry is discussed three countries only are usually mentioned—France, Germany and Austria-Hungary, but here it should be noted that it flourishes equally well in many smaller countries. It seems to me a striking fact that a small country like Sweden, with its population of 5,476,000, that is to say, less than Greater London, should be able to support a sugar company with a capital of no less than £7,500,000, operating twenty-one factories. Denmark, with its population of 2,600,000, has two large companies which have been very successful; and even such industrially backward countries as Italy and Spain manufacture their own sugar. The number of acres under beet cultivation in the various countries referred to was then five millions, whilst in Great Britain we had last year, and for the first time, a few hundred acres, mostly growing experimental crops, the larger portion of which was exported and sold to foreign manufacturers.

What is the reason of this? In the first place, the continental industry originated under the pressure of circumstances caused by the difficulties of obtaining cane sugar during the Napoleonic wars, and continental nations at once realised the importance of the industry. By direct bounties, by remission of taxation, and by various forms of encouragement, the industry was gradually developed, huge sums were spent in improving the method of manufacture, whilst we here in England were first of all satisfied with our imports of cane sugar, and afterwards, in our pursuit of cheap supplies, we were content to profit by the surplus of beet sugar from the Continent, which was sent to these markets and frequently sold at prices considerably under cost. By their system of taxation, and by their bounties, foreign manufacturers, protected by their tariffs, were able to make large profits in the supply of their own markets, and to send us their surplus at any prices which could be realised.

Under these circumstances, it became impracticable to make a start here on commercial lines, because, very naturally, nobody in his senses would put up capital for an industry which was liable at any time to be undersold and destroyed by foreign bounty-fed supplies. This bounty-fed sugar not only had the effect of stopping any development in our country, but it also began to do great harm to cane sugar. Continental consumers became restive in consequence of the high prices of sugar in their own countries, but their respective governments and manufacturers were so jealous of each other that it was a matter of great difficulty to get them together for the purpose of mutually agreeing to abolish the bounty system. This, however, was at last effected by the Brussels Convention in 1903, and from that moment it became possible

for the first time to look upon the sugar-beet industry as one which might be profitably established in the British Isles. It is difficult to understand the short-sighted attitude adopted by those who at the time so hotly opposed the Brussels Convention.

During the long period of inaction, however, various prejudices had sprung up, and owing to one or two unsuccessful ventures some forty years ago, when neither the machinery for extraction, nor the sugar-beet itself, was so highly developed as it is to-day, the public over here got the idea that the British climate was unsuitable for the proper ripening of the roots. It is only by constant experiments that we have at last been able to convince people, who ought to have known better, that roots quite equal to, if not better than, those grown on the Continent can be produced in these isles. We have proved conclusively that excellent sugar-beet can be grown here, and it has now become a business question pure and simple as to whether the growing can be made to pay.

After all, it is difficult to see why the climate question should ever have been raised at all. The industry is a profitable and lucrative one in Northern France, Holland, and Belgium, with climates very much akin to ours, and it seems strange that there should be any valid reason why with us the industry should be impossible, or of no commercial or agricultural value at all. It was always contended that we had not enough sunshine here, but sunshine is not everything with beetroot. It requires a considerable amount of moisture in the spring and summer, though fine weather in the latter part of August, in September, and October is of great importance for the purpose of creating a sufficient percentage of sugar in the roots. I think the experience with our climate is that we usually have a very fair amount of fine weather during these months.

Then we are told that the question of labour is an insuperable one. That certainly is a difficulty, but it is one which ought to be got over by careful organisation. It is true that far more labour is required on the land for beet cultivation than is the case with our present system of agriculture. But is not this what is wanted? I should have thought that the fact of this labour being required would make all thoughtful persons desire to spend some public money in the encouragement of such an industry instead of utilising it for doles to unemployed and the establishment of labour colonies.

Wages on the Continent have been steadily rising for years past, and in many parts, where the sugar industry is quite successful, labour is fully as expensive as in this country. It is quite a mistake to state that beet cultivation cannot be carried on without a large amount of cheap imported labour. It is perfectly true that in the huge beet fields that are found in some parts of Austria, in the Magdeburg district of Germany, in Denmark and Sweden, it is the practice to import every year large numbers of labourers—frequently women—from Poland, Lithuania, and other countries. In the Magdeburg district some nine hundred Polish women are imported every year to do the singling of the roots, the careful and necessary hoeing, and to assist in the lifting at the end of the season. They are housed in barracks built for the purpose, fed, and looked after, and the cost of all this, together with the wages, comes out at about 2s. 6d. a day, which cannot be said to be absurdly cheap for female labour. It is a healthy occupation, and I will undertake to say that these women who work in the beet fields, produce far stronger children than many of our British women who spend their lives in the unhealthy atmosphere of factories, workrooms and slums. A large amount of extra labour is now obtained from our

towns for pea, fruit, and hop-picking. Why should it be impossible to organise such labour for beet culture? There are, however, many places on the Continent where these large beet farms are not found, and where beet is raised without the aid of imported labour.

From the point of view of machinery and plant, we have a distinct advantage in this country. The continental industry has been built up and developed stage by stage, and while many of the factories are modern, well-equipped, and up-to-date, others have antiquated plant, and are laid out in an uneconomical manner. If we could start the industry here we should be able to avail ourselves of all the accumulated experience of Continental engineers. We should have nothing but the best and most up-to-date plant, and after we had got well started we should be able to compete on satisfactory terms with the large run of continental factories. We have also an advantage in our cheap and excellent coal and lime, and it should be remembered that many foreign factories have to be run with imported English coal. Seeing that a factory dealing with some 80,000 tons of roots would be consuming about 6,000 tons of coal in the course of a three months' "campaign," it will be appreciated that this question of fuel is an important one.

Then again, we have the advantage of ready local markets amongst our own people for the refined granulated which it is proposed should be manufactured. This would mean a saving in the matter of freights, rehandling, and profits.

Now, why is it that we are experiencing such trouble in making a start? The main difficulty is this: besides being new to our people, it is an industry in which you have to show two profits. If the growth of the sugar-beet is not a profitable crop to the farmer he won't grow it, and so the factories cannot obtain the necessary supplies. Then again, if the factories fail to make a profit by selling their finished product, they cannot continue working, and the industry as a commercial proposition becomes impossible. A factory, therefore, has got to pay the farmer such a price as will satisfy him, and, at the same time, not make it impossible to earn profits. The whole question, therefore, hangs on what price a factory can get for its output and for its by-products, and on its manufacturing costs.

I will now proceed to deal very briefly with the agricultural side. There are many people going about saying that the time for experiments has passed, and that what we want is something practical in the way of a factory. This latter is very true, but the time for experiments is by no means passed. The time for small experiments, to show that we could grow the root, has certainly gone by, but we are still with very incomplete data for the purpose of showing the actual quantity of sugar per acre we could produce in commercial quantities, and the cost of growing it. Many of our experiments lead us to think that with our moist climate we can do rather better than on the Continent, but we want further proof of what we can really do year-in year-out when growing beet as a commercial crop.

I speak advishly of sugar per acre instead of weight of crops, because our farmers, who are accustomed simply to judge root crops by their weight, have to be educated to understand that unless you can produce a satisfactory percentage of sugar in your roots, a heavy crop is not necessarily better than a lighter one. If by growing a high quality beet Mr. Jones can produce, with fifteen tons to the acre, as much sugar from a given area as his neighbour Mr. Brown does with seventeen tons to the acre, then Jones is the better off, because he has two tons of roots per acre less to lift and cart to the factory, and the factory has less matter to handle and work.

What is now wanted is the growing of some experimental crops of ten acres or more on properly-prepared ground and under the careful supervision of experts. If this can be done in various localities, and a careful record kept of all expenses, together with the *actual* weight—not the estimated weight of the crop—and reliable analyses of the roots, the information obtainable will be of a very valuable nature. Such crops, too, grown in different districts would have a high educational value, and would enable surrounding farmers to see how beet should be grown if it were being produced to supply a factory, and to note the results on rotation crops. As far as we have been able to judge by the experiments that have already taken place, the cost of producing an acre of beet should not exceed £10 to £11, including rent and the cost of raising. There is much to be learnt as to the provision and organisation of the extra labour required for thinning, hoeing, and lifting roots when grown in quantities, but on good land it should be possible to grow crops of fully 13 to 15 tons per acre, and with a sugar contents of 15 to 19 per cent. This, however, must vary somewhat with the seasons. Now, the ordinary farmer will not grow a crop of the size indicated unless he can find either a profitable market, or else be guaranteed against loss, and therefore it is necessary that those who would embark on such experimental crops should in some way or other be guaranteed such a price as they would get if a factory were erected and working in their neighbourhood. If the farmer could grow 15 tons of beet and be paid £1 a ton for 15 per cent. of sugar, with a bonus for every unit of sugar above this figure, he ought to make a profit which is well worth his consideration.

It must be remembered as well that the leaves of a sugar-beet crop are far more abundant than those of mangels or swedes, and that, either dried or fresh, they are excellent fodder for all kinds of stock. In a crop of beet producing about 15 tons of roots I am informed that about six to seven tons of more or less withered leaves would also be produced, whilst the fresh leaves often weigh as much as the roots themselves. These are of considerable value either as cattle food or for ploughing into the ground, and I believe it is generally calculated that the value of the leaves for either purpose is about equal to the cost of lifting the roots—say about 20s. or 25s. per acre. In connection with this I may state that a German specialist, Mr. L. Kuehle, of Gunsleben, in a paper he read in October, 1910, before the Magdeburg Committee of sugar manufacturers, made this startling announcement. He said that the drying of these beet leaves was a matter of very great importance. Germany had some 500,000 hectares* under beet, and harvested some 10,000,000 tons of green beetroot leaves from this area. Artificially dried these would weigh about two and a-half million tons (metric), of which the nutritive value calculated according to analysis of Prof. Kellner equals some 7 marks 27 pf. per 100 kilo, or an annual value of 180,000,000 marks. Now, the harvest of green leaves, taking into account the loss in siloing, would not be more than two and a-half million tons of the value of 10,000,000 marks a year. I leave this gentleman responsible for these figures, which have been reproduced in many technical journals without criticism. It is, however, a mistake to simply judge of the value of sugar-beet by comparing the price which the farmer obtains for his crop with what he would get for a crop of mangels. An excellent report was issued last year by a deputation of three practical gentlemen who were sent by the Maidstone Farmers' Club to Germany for the purpose of studying

* One hectare=2.4711 acres.

the question. They summarise their opinions as follows :—

The importance and value of beet growing is not to be gauged by the profit to be derived from the crop itself, but rather by its effect upon the whole rotation, or rather upon the whole economy of the farm. It amounts to a premium on good farming. Whereas an English farmer is commonly bound by contracts in his lease or agreement (which he constantly evades, and which he is now encouraged by law to evade) not to sell straw off the farm without bringing on a manurial equivalent, the beetroot grower has every inducement to use his straw upon the land.

Whatever rotation he uses, and there seems to be plenty of variety in the matter of rotation, he looks to the fallow or cleaning crop (beets) to yield the best return of the series. He gets back from the factory a large quantity of excellent feeding material, which he can only turn to the best account by feeding to stock, and for the purpose he requires all his straw for chop and litter. After deep ploughing and fairly heavy manuring for beets, he naturally gets a splendid crop of wheat at a very moderate cost—twenty centner per morgen (seven quarters per acre) seems to be a pretty generally recognised average. It is the common practice to take another white straw crop after wheat, which shows the lasting effect of the cultivation for beets.

To our minds the great point to be remembered is that the year of *least* profit in any of our rotations is turned into the year of *greatest* profit on a beet farm. The farmer *lends* the produce to the factory, and receives it back slightly reduced in feeding value, but with all the salts and minerals derived from the soil quite intact and ready to be returned to the land from which they were extracted. It is not surprising that a few years of this treatment increases the letting value of the land. Agricultural land in the neighbourhood of Magdeburg has doubled in value since the introduction of beet growing.

Now for another point which has been raised against beetroot by several gentlemen who do not appear to have studied the question sufficiently. It has been suggested that a beetroot crop is essentially an exhaustive one to the soil. Obviously it is quite impossible for me to deal with the question fully in this article, and I confine myself to quoting an authoritative opinion, that of Prof. Ware. This well-known American authority and author of several works on the sugar-beet, in his important book of several hundred pages on cattle feeding with sugar-beets, sugar, molasses, and sugar-beet residuum, writes :—

The ash absorbed by growing one ton of mangels is 38.2 pounds, while with beets it is 34.5 pounds, thus proving mangels more exhausting to the soil than sugar-beets. If we admit that twenty tons of mangels may be grown to the acre, a total of 764 pounds of plant food will be absorbed. If ten tons are an average * yield to the acre for sugar-beets, the ash taken up by that crop will be 345 pounds. Consequently we are not far from correct in asserting that by neglectful cultivation it will take one-half the time to ruin the soil in growing mangels than it does with beets. If, on the other hand, scientific rules of cultivation are practised when growing beets, the diminution of the fertility of the land need not be dreaded.

There is no doubt that the proper way to gauge the value of sugar-beet is to consider it with respect to the whole rotation of crops. I believe it is quite erroneous to look upon it as an exhausting crop. If it were, why is it that in Germany it is followed without further manuring by a heavy crop of wheat? There is no getting away from the fact that wherever sugar-beet is grown it increases the fertility of the land and the value of the succeeding crops. I was assured by leading men in the Magdeburg district last year that if beet cultivation were to be abandoned there, the result would probably be a diminution of some 25 per cent. in the value of the wheat crops. Beet cultivation requires that the ground should be ploughed deeply and farmyard manured in the autumn. If not ploughed deep, the roots are apt to grow fangy: these are bad for factory purposes and are difficult to clean. The opinions of men of the highest authority in various countries could be quoted to show the wonderful effect of the beet crop on those following and the way that everywhere beet cultivation has raised the value of the land, but a few striking statements taken from

* The average in America.

an official paper presented to the United States Senate, entitled "Changes in Farm Values, 1900-1905," may suffice.

It says :—

The beet-sugar industry, where installed, has been one of the most potent factors developing agricultural conditions, not only in sugar production, but in all agricultural features associated with it. As this industry develops in the West, it is the main feature attracting and supporting many things and uniting them in an intensive agricultural husbandry. As it works out in the West it is the "Mother Lode" of Agricultural development. It is, and will continue to be, the most important medium developing the benefits and promoting the success of our national reclamation act. Through its by-products in the older States it has asserted a strong influence on agricultural interests. It has stimulated the animal industry and the consequent products of the same. The effect of the beet industry on "local business generally" has been very pronounced. Where installed it has remarkably recouped and energised all kinds of local business. It has revived and made our towns already established. In places where towns did not exist it has made new ones which have become important centres of trade.

Reverting now to the cultivation, the roots must be carefully singled and singled at the right time, and then the hoeing must be continuous, and must be done so as to entirely cover the roots with soil. When once the leaves are well up, they shade the ground so completely that weeds cannot flourish, and, consequently, sugar-beet is particularly valuable as a cleaning crop. The worst of it is that the British farmer is very slow to move in a new direction, and he naturally requires to be convinced, first of all, that the beet will pay him to grow; and, secondly, that beet slices constitute a cattle food worthy of his attention. In consequence of all this, it will probably be very difficult to obtain adequate supplies for a factory unless a really tempting price is offered for the roots.

Now we come to the factory difficulty. The industry is one which does not permit of small factories being economically, that is to say successfully, worked. It is inadvisable to erect a factory to treat less than 50,000 to 60,000 tons of roots in the season; 100,000 would be still more desirable, and such a factory, with its necessary working capital, involves a sum of from £120,000 to £150,000. Ample working capital is essential for many reasons. It is not easy to get a sum of this description together for a new venture, and it is for that reason that I have been agitating in favour of Government assistance for the purpose of enabling the first factory to be built, and so proving the industry by actual manufacture. In any new industry the manufacturing costs at the outset must, of necessity, be higher than later on when men have settled down and learnt their places in their work, and ascertained the most economical way of handling materials. This is generally found to be the case in any new factory erected on the Continent where the industry is thoroughly understood. How much more must it be so here in England?

Another difficulty facing a factory in England at the outset is the important one of carriage of roots. Until the farmers have acquired confidence and experience, it would probably be necessary to cover a large area for the purpose of obtaining sufficient supplies of roots for a factory. Now, the greater part of the carriage of these roots from distances would have to be borne by the factory, because if it had to come out of the farmers' profits, those at a distance would not grow the roots. As the farmers acquired confidence, however, it is not unreasonable to suppose that the men in the neighbourhood of the factory who began by growing ten acres would very likely grow twenty or thirty, consequently supplies could be obtained from a less extended area, and the costs of carriage would greatly diminish. For a factory working 50,000 tons of roots a year, supposing one-half the quantity had to bear

a cost of 3s. per ton for carriage, that would be equal to £3,750, or 3½ per cent. on a capital of £100,000, a very serious item of expense. Any assistance, therefore, which can be given the factories during the first few years of their existence would materially aid in attracting capital.

The question is, how can it be done? and it is unfortunate here that we bump right into the thorny domain of party politics. May I be allowed to say that I do not wish to offend the political opinions of anybody, or to advance any political arguments of my own. I merely wish to state certain facts from which readers are at liberty to draw any arguments they please. I wish, however, that it were possible to eliminate all party politics in a matter of this sort, for one party is sometimes as bad as the other, each one trying to score off the opponent. If we could have more consideration of this question from the point of view of the good of the country and less from that of party politics, it would be better for all concerned. By the Brussels Convention we are precluded from anything in the shape of bounties either to factories or to growers of beet, but in that Convention it is specially stated that any country is permitted to protect its own sugar to the extent of not more than 2s. 6d. a cwt. The present import duty on raw sugar is 1s. 10d. a cwt., and if this import duty was maintained and no excise duty levied for a term of years, the advantage to a factory turning out 5,000 tons of sugar would be a matter of about £9,000 a year, and might make all the difference between profit and loss in the initial years of difficulty and of the abnormal expenses I have alluded to.

In a pessimistic paper that was read last year before the Surveyors' Institution, reference was made in the following words to this request which had been put forward for Government consideration of the industry:—

"The Government has been asked to assist the industry for five years. What use is that? Who would invest capital on a chance that at the end of five years it would be lost. Another large portion of the capital would have to be invested in machinery. But machinery does not last for ever, and even supposing we give it a life of twenty-six years, at the end of that time the capital will be lost unless there has annually been put aside a sum equivalent to the annual depreciation."

As I was the culprit who first of all asked in Parliament for this term of five years' consideration, I would like to point out that for reasons already stated I believe that assistance for this term would be of material benefit. I wish, however, that we could go as far as they did in Austria in 1831, when, after discovering the importance of the beet industry to the nation, all taxation was remitted for a term of ten years, and, as a consequence, factories were rapidly run up, and no less than half a million tons of beet were grown in the first year. The industry went ahead by leaps and bounds, and in the season 1909-1910 the estimated figures of sugar-beet grown were 8,100,000 tons converted into 1,248,000 tons of raw sugar of which over 700,000 would be exported.

It has been suggested that a large grant might be made from the Development Fund for the purpose of erecting an experimental factory. If this can be done it will be of very great assistance, but, at the same time, besides the necessity of overcoming the difficulties attendant on the provision of capital, it is equally important to make it possible for that capital to earn a profit afterwards. If through being unable to sell the products at such a price as will show profits in spite of initial difficulties, a factory, in the early stages of the industry, goes to the wall, a great set-back will be given to the whole movement. I do not

at present see any legitimate way of overcoming these initial difficulties except by assistance in the way indicated. Once these difficulties were overcome and experience gained, the factories might very likely be able to stand alone.

The most practical idea that I have heard put forward is that the Development Commission should purchase a tract of some 5,000 acres of suitable land around a good factory site and lease this on easy terms to an approved company, which could thus produce itself most of the beet it required, and under proper conditions which would be an object-lesson to the whole country.

I am convinced that the capital for the factory could, under these circumstances, be found. Arrangements could easily be made for growing tobacco, hemp, and the other experimental crops mentioned in the Commission's recent report, whilst the capital value of the land would be steadily increasing under the influence of the new cultivation.

An objection raised in the paper referred to was to the effect that there could be no security for the capital which would have to be invested in expensive plant and buildings which would then be of little value if the factory proved a failure. Such an argument might just as well be directed against any form of industrial enterprise, and if it had been the practice of our forefathers to invariably work on these lines, we should never have become the great manufacturing nation that we are.

Equally surprising was the extraordinary remark as to the necessity of writing off an adequate sum annually for depreciation of plant. I am not aware that this is a proceeding peculiarly necessary in a sugar factory, and I think that any business man will agree with me that any manufacturer, in any line of business, who did not follow this practice would soon come in conflict with his auditors and end in financial disaster.

I agree with all that critics have said with regard to the necessarily conjectural nature of many of the estimates of profit that have been put forward respecting the possible earnings of factories, but many estimates of loss are just as conjectural, and some quite erroneous. I can only repeat that if sugar factories are commercially successful in other countries no valid reason has been shown why they should not be made commercially successful here, having regard to all the points that I have mentioned.

I do not agree either with some people as to the value which can be placed on what are known as the beet slices for the purpose of cattle feeding. I only know that the dried form in which slices are now turned out causes them to meet with high approval on the Continent of Europe, where £5 and £6 a ton is readily paid for them, and where the demand is greater than the supply, and there is reason to believe that in our large towns, where so many mangels are bought by cow-keepers, when once dried slices became known they would be highly appreciated. Mangels contain over 85 per cent. of water, and as a Lincolnshire farmer, who is a great believer in these slices, said to me not long ago: "Why should a cow-keeper continue to pay carriage on 85 per cent. of water if he can buy dried slices and has got a pump in his own backyard?"

The figures which are sometimes given of dividends and profits earned by foreign sugar factories should certainly be regarded with great caution. A list of such dividends appeared in a recently-published document, and one factory was there said to have earned 108 per cent. That might have been so, but this figure is entirely misleading unless accompanied by details setting out the capitalisation of the factory, and whether it has not been largely written off by profits earned during the many years of high prices and prosperity. The system of financing factories on the Continent is so entirely different from what we shall probably have to contend with here, that comparisons of this sort are apt to be very deceptive. I don't think myself that any great fortune is to be made out of the factories themselves. If we can attain an average of 5 to 10 per cent., we should be content with that. If greater profits than these can be made, then all the better, but do not let us start with inflated estimates. The last two years have witnessed abnormal sugar prices through the vagaries of the weather, and as there is a great shortage of seed for the present sowings it is likely that prices will not be normal this autumn, and indeed the present forward prices for October sugar are 1/6 to 2/- per cwt. above the normal ones.

In considering the prospects of establishing a permanent industry which can only be so if it returns satisfactory average profits over a term of years, it is not sound policy to base calculations on anything but what is regarded as a normal price, *i.e.*, about 10/- per cwt. f.o.b. Hamburg for the raw 88% beet.

Much useful information will be gained this year by the operations of the factory now in course of erection in Norfolk by the Anglo-Netherland Sugar Corporation that was floated last autumn. This company, by its prospectus, is dependent on profits obtainable from its old-established Dutch factories, and claims that it will be able to pay the interest on its bonds even if the English factory shows a loss for a year or two.

If, however, no capital for factories in England can be obtained except in conjunction with foreign established factories, then the establishment of a home industry will be a very slow and difficult process. On the other hand, if we could have in this particular case a relaxation of our present fiscal practice to admit of no tax being levied on home sugar for a term of years, whilst still maintaining the import duty of 1/10 per cwt., I make bold to say that capital would be forthcoming for the erection of factories in many localities, and to the great advantage of agriculture and the cause of rural and industrial employment. I have discussed this matter with many ardent Free Traders, and several of them, when they have once grasped the situation, have declared the proposal to be sound and desirable. To my obtuse mind it seems contrary to all common sense to insist on taxing food if grown in this country simply be-

cause the same food is taxed when it comes from abroad, and when the absence of such home taxes would undoubtedly cause a great and much-needed industry to spring up in our midst.

These remarks are made in no partisan spirit, but as mere statements of fact which can perhaps be carefully considered, and all I wish to say is that this proposed treatment of sugar manufacture as an "infant industry" on the lines laid down as permissible under Free Trade by John Stuart Mill, is the only real practical way of hastening its establishment in these Islands.

In conclusion, special attention might be directed to the great assistance which the sugar industry might render to the co-operative movement. I can give an interesting instance of a successful co-operative sugar factory being recently launched in Holland. This is the Dinteloord Factory, of which a print appears on the following page, and in which the farmers, to the number of 700, are shareholders, holding 3,430 shares of £36 each, of which £5 per share has been called up; the balance of the money was found by banks.

The order for the factory was only given in the month of January, 1909; building was started in February; 65,000 tons of roots were treated in 1909, for which 21s 8d. per ton was paid, and in 1910 87,000 tons of roots were treated, for which 25s. 1d. was paid. Why is no such scheme possible in England?

In many districts it would be most desirable that the factory should have the control—either by ownership or lease—of a considerable acreage, say, 2,000 or 3,000 acres. This would enable the agricultural profits from improved crops and stock feeding to be combined with the manufacturing profits. A successful enterprise of this description would give a great impetus to the starting of factories on a co-operative basis, whereby those who provide the roots are themselves interested in the profits of the factory, as is so often the case in successful continental factories.

This, I submit, is the really sound way of running the sugar industry.

A hundred factories working in the country would only give us about one-third of our sugar consumption. The capital expenditure for plant alone in these factories would be well over six millions, to say nothing of the upkeep and renewals. The real benefits from the industry will be derived from the improvement of our agriculture, and the amount of employment afforded in the rural districts and in the engineering trades.

It is extremely difficult to get the British farmer to combine in any form of co-operation, although we see the immense benefits of such a

system in Denmark, Germany, and Holland, and more recently in Ireland. Greater co-operation amongst out agriculturists would be a lasting benefit to the country, and no industry that I know of offers such inducements to successful co-operation as the one with which this article has attempted to deal. I wish once more to urge in the strongest possible way that this question of establishing a sugar industry is one of national importance, and if it could be made successful its extension would be rapid and its beneficial results far-reaching.

DENBIGH.

April, 1912.

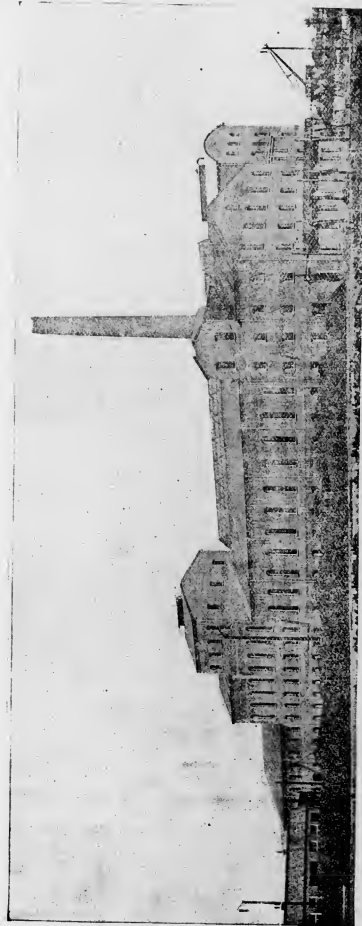


THE CO-OPERATIVE BEET SUGAR FACTORY AT DINTELOORD, HOLLAND.
The above illustration appeared in "*The Journal of the Board of Agriculture*" for March, 1912, and is reproduced by kind permission of The Controller of His Majesty's Stationery Office.

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A GUIDE TO THE CULTIVATION OF SUGAR BEET.

By R. N. DOWLING, N.D.A., etc., *Agricultural Adviser.*

The following information for the cultivation of the Sugar-Beet crop is given as a guide; but it is, of course, understood that different soils and districts will call for variations in the field operations, and that the farmer will be the best judge as to the general treatment of his particular farm or field, although the details mentioned have a specific importance for the welfare of this particular crop.

It will be well to remember that the Sugar-Beet and the Mangold belong to the same species (*Beta vulgaris*), and that the characteristics, requirements, and treatment of the two crops are very much alike.

SOILS.

The ideal Sugar-Beet soil is a nice deep friable loam, but successful crops can be obtained on almost any soil that will produce a fair crop of Mangolds, providing there is sufficient depth. It is characteristic of beet cultivation that it greatly improves the fertility of all soils, particularly those of a poor quality, such as very light sands.

AUTUMN CULTIVATIONS.

- (1.) Clean the stubbles after harvest.
 - (2.) Apply a dressing of 10 to 15 tons of farmyard manure per acre. It is better that the dung should be applied before the deep ploughing in the autumn, or, at the latest, during the early spring (in which case it must be well rotted), because fresh dung produces "fanginess" and coarseness of the root.
 - (3.) Deep plough, followed by subsoiler if necessary, as early in the autumn as is consistent with the nature of the soil. This subsoiler follows behind the plough in the open furrow, or it can be done by a subsoiler attachment to the plough, or by another plough with the mould-board removed. A greater depth of worked soil is required for Sugar-Beet than for Mangolds, because the beet-root should grow like a well-shaped parsnip, and if it meets with resistance in the shape of a hard "plough pan" or unworked soil, it will become "fanga," which makes the "root" unsatisfactory from the Factory point of view both as regards sugar and the working-up of the "root."
- Fanga "roots" are often the cause of the high percentage of "tare" that is sometimes obtained in experimental areas, and such condition is generally due to insufficient depth of worked soil.

The "tare" is the amount of dirt to be deducted after washing the roots at the factory, generally about 10 % to 20 %. The farmer does not wash the beet-root.

It will not, of course, always be necessary to subsoil, because, in the course of time, ploughing would tend to get deeper, and we should have a greater depth of worked soil available for plant life prevailing in the Sugar-Beet areas.

SPRING CULTIVATIONS.

The customary operations of preparation for the Mangold crop to be carried out to obtain a fairly fine tilth or "season," together with firmness of seed-bed and a loose, friable condition below.

MANURING.

Sugar-Beet requires Nitrogen, Phosphoric-acid, Potash and Lime.

These constituents may be in the soil in a more or less degree, and the manuring must be carried out accordingly.

Although a general or "complete" manuring is generally necessary, it must not be thought that the Sugar-Beet is a gross feeder.

The following quantities are given as a guide, but the manuring would vary according to the soil and conditions:—

10 to 15 tons of farmyard manure per acre, applied in the autumn or not later than the early spring when possible.

3 to 5 cwt. of Superphosphate.

$\frac{1}{2}$ to 1 cwt. of Sulphate of Potash.

$\frac{1}{2}$ -cwt. of Sulphate of Ammonia.

The above mixture to be applied soon after it is made, before dressing the land down for drilling.

If the soil is inclined to be acid, it is well to apply a dressing of lime in the autumn or during the winter (where factories are in existence "factory lime" is always either given or sold at a low price to the farmer), and Basic Slag might be with advantage substituted for Superphosphate. As Slag is not so quickly available, it should be applied early.

KAINIT.—About 3 cwt. of Kainit can be used instead of Sulphate of Potash, but it should be applied earlier.

NITRATE OF SODA.—From $\frac{1}{2}$ to 1 cwt. of a quick-acting nitrogenous manure, such as Nitrate of Soda, should be applied soon after the plants are up, or directly after singling. This manure is very soluble in water and quickly available for the use of the plant, and will help to prevent a check from wire-worm or other causes. It also assists the deep-rooting nature of the plant, and thus helps it to resist the effects of drought. It induces healthy leaf-formation; and, as sugar is manufactured in the leaves before being transferred to the roots, it will be seen that healthy foliage is a point to be aimed at.

Another one or more dressings of $\frac{1}{2}$ to 1 cwt. of this manure should be applied if required, but an excess will cause late ripening and dark-coloured coarseness of the foliage, which is not desired.

FACTORY LIME.

	Per cent.
Organic matter	21.23
Potash (K ₂ O)	.46
Phosphoric Acid (P ₂ O ₅)	1.28
Lime or Calcium Carbonate (CaCO ₃)	9.25
Water	49.80

DRILLING.

15 to 25 lbs. of seed per acre, drilled on the "flat."

Drilling should *not* be on the ridge, because it produces "roots" with too much "top" out of the ground.

TIME OF DRILLING.—About the same as for Mangolds, *but an early date within reason is wise*. Too early drilling, if followed by cold weather and a check, causes bolting of the plants later on.

DRILLS.—Mangold drills can be used *if not too wide between the rows*. The drills in ordinary use can be quite well adapted by shutting off the intervening coulters. The seed should not be buried to a greater depth than three-quarters of an inch, the distance between the rows being about 14 to 18 inches, according to conditions (14 to 16 inches is the usual width on the Continent).

It is important that good seed should be used, having a well-known history, as inferior qualities produce "roots" of a low sugar content. Firms such as Messrs. Rabthege & Gieseke, of Klein-Wanzleben, produce seed on the very highest scientific principles and having very lengthy pedigrees for sugar production.

ROLLING.

It is essential that the soil should be firmly pressed round the seed, and to obtain this condition rolling should be resorted to after the drill.

HOEING.

The horse-hoeing should be started at the earliest possible date, and continued several times during the growth of the plant. Hand-hoeing should also be done as early as possible, and the plants bunched and singled out to a width of *from 8 to 9 inches*, care being taken that no doubles be left in the row. Hoes with 7-inch blades are generally used. On the Continent singling is done by hand, after the "bunching" is finished. Children and women work on their knees and take care to leave the strongest plant of each "bunch" when pulling the others out. The fingers and thumb are placed round the plant it is desired to leave, while, with the other hand, the remainder of the "bunch" are pulled, then the soil is firmly pressed round the remaining plant to ensure firm root-hold and healthy growth.

If the hoeing operations are carried out early, continually, and thoroughly, the crop will undoubtedly be enhanced both as regards quantity and quality. Hoeing not only cleans the land, but it ensures a nice "tilth" on the surface. Such a condition prevents evaporation of the soil water, and thus helps the plants to resist drought. Hoeing the land also helps the free entrance of air and warmth to the soil, which is very beneficial in assisting the bacterial action, known as "nitrification" or the formation of nitrates. Hoeing also assists in other ways.

Care must be taken to see that the soil is drawn to the plants, and not away from them at the final hoeings.

Horse and hand-hoeing should be continued as long as the plants will allow.

The cost of hand-hoeing and singling should be about 15/- to 25/- per acre.

The hand-hoeing is often done on the Continent by gangs of Russian-Polish women, who work usually on the piecework system; but if paid by the day the wages come to 2/6 a day—i.e., 1/3 to 1/6 a day in cash, plus housing, firing, lighting, milk, potatoes, etc., to value of 1/3 a day. Singling is usually done by school children on half-holidays or after school-time.

The horse-hoes are fitted with the usual "A" or "V" shares and "L" shaped blades, and do five rows at a time.

LIFTING.

The lifting can be done by proper hand tools or with lifting ploughs. Failing these, it is very practical to run one of our ordinary farm ploughs close up beside the row, thus ploughing away the soil from one side and leaving the beet sufficiently exposed to be easily pulled by hand.

As the beets are pulled they should be laid in rows, and the tops and leaves chopped off with a specially-constructed chopper. As any portion that has been exposed above ground is *valueless for sugar making*, it is necessary that the beet should be topped, so that *the green part is left with the leaves*. It is usual for the beet to be topped about $\frac{1}{2}$ -inch to $\frac{3}{4}$ -inch below the crown.

The beets are then thrown into heaps ready to be conveyed to the factory.

In cases where the beetroots are to be fed on the farm the areas that are not weighed can have the leaves wrung or chopped off in the usual way.

The cost of lifting, topping and putting into heaps on the land should be about 25/- to 30/- per acre when the whole crop is topped as for a factory. Growers will receive advice and assistance from the Association; and, in districts where any extensive area is being grown, it is suggested that the proper ploughs or tools shall be obtained for the use of growers.

GENERAL INFORMATION.

ROTATION OR PLACE IN CROPPING.—As a rule, Sugar-Beet takes the place on the Continent of our Mangolds, Swedes and Turnips, and is grown either once in three years or once in four, and rarely every other year.

In the great Sugar-Beet areas around Magdeburg the general system is a four-course one—i.e., Sugar-Beet, Barley, Seeds, Wheat, but a six-course rotation is often preferred.

- | | |
|--------------------|----------------------------|
| (1.) Sugar-Beet. | (4.) Barley. |
| (2.) Spring Wheat. | (5.) Seeds (Clovers, &c.). |
| (3.) Sugar-Beet. | (6.) Wheat. |

In this way Sugar-Beet is grown twice in six years, and Clover only comes once, thus helping to prevent "clover sickness."

We mention some other rotations:—

- | | | |
|---------------|---------------|---------|
| (1.) Beet. | Beet. | Beet. |
| (2.) Barley. | Summer Wheat. | Wheat. |
| (3.) Chicory. | Barley. | Barley. |
| (4.) Wheat. | Potatoes. | Clover. |
| (5.) Beet. | Beet. | Beet. |
| (6.) Barley. | Wheat. | Wheat. |

It is probable that Sugar-Beet will replace a portion of our root crops, and will be grown alongside Mangolds, Swedes and Turnips, which crops will be fed in conjunction with the residual sugar-beet pulp to all classes of stock.

It will also probably take the place of barley or other straw crops, as well as ordinary roots in Fen districts, or where barley gets "laid" and is of a poor quality.

Different districts and different local conditions will undoubtedly call for different systems of cropping; and, therefore, the continual controversy about Sugar-Beet *v.* Mangolds is not nearly so important in practice as it would at first seem. *In Holland both crops are largely grown on the same farms.*

FEEDING OF SUGAR-BEET PULP OR SLICES WITH LEAVES AND TOPS.

The pressed wet slices are taken back by carts that have delivered beets. When beets have been delivered from a distance it is often the custom to return the slices dried. These are bagged as with dried grains.

If the farmers live near the factory they prefer to have the pressed wet slices, and these are put into clamps or in pits in alternate layers of 2ft. to 3ft., with the leaves and tops, the whole being "drawn" to consolidate in the same way as when we draw our carts over the dung mixens. The clamp is then covered with earth to a depth of from 1ft. to 2ft., and, if properly made, this silage can be kept for two years, or even longer, or it can be opened after about two or three months.

Thus, in a year of high yields, clamps are kept over to guard against small crops, such as were experienced in a year like 1911.

It is necessary to ventilate the clamps for a time as with Mangolds, and also to allow the drainage water to escape.

In the Sugar-Beet areas of Germany and Austria no other root-stuff besides beet slices are used for feeding to cattle, *but in Holland and some parts of France Mangolds are fed in conjunction with the pulp.*

MOLASSES.

Molasses or so-called "agricultural treacle" is a by-product of the sugar factory, being the uncrystallisable portion of the beet juice. It is largely used for the production of alcohol, and for feeding purposes; it is fed direct, or made up into various mixtures with millers' offals, chopped straw, etc.

Before using it should be mixed with warm water, and poured over the chopped straw and thoroughly turned.

Care must be exercised in using it because of its "opening" effect. Taking 1,000lbs. live weight of an animal as a guide, the following quantities may be fed:—

Fattening beasts	..	..	..	4 lbs.
Sheep	..	..	..	3 "
Cows	..	..	..	2 "
Horses	..	..	..	2 "

Agricultural treacle is not usually fed to animals nearing parturition, because it is said to be liable to cause abortion.

DAILY RATIONS ON A TYPICAL DAIRY FARM IN GERMANY
WHERE 200 COWS ARE KEPT, THE MILK BEING SOLD
WHOLESALE AT 6d. GALLON.

COWS IN-MILK.

8 lbs. Dried Sugar-Beet Pulp.
8 lbs. Ensilaged Sugar-Beet
Leaves and Tops.
4½ lbs. Cotton Meal.
2 lbs. Bran.
8 lbs. Oat Straw.

FARM HORSES.

1 to 2 lbs. Dried Sugar-Beet Pulp.
15 lbs. Oats.
2 lbs. Beans when working hard.
9 lbs. Hay.

SHEEP.

1 lb. Dried Sugar-Beet Pulp.
1 lb. Molasses.
1 lb. Poppy Seed Cake.
1 lb. Kibbled Barley.
5 lbs. Ensilaged Leaves and Tops.
1 lb. Maize.
1 lb. Rice Meal.

DAILY RATIONS ON A FARM IN HOLIAND.

FATTING BULLOCKS.

180 lbs. wet or 18 lbs. dry pulp, or 140 lbs. Mangolds, plus other concentrated foods.

STORE CATTLE.

60 lbs. wet or 6 lbs. dry pulp, or 40 lbs. Mangolds, plus meals and hay or straw.

COWS IN-MILK.

50 lbs. wet or 5 lbs. dry pulp, or 40 lbs. Mangolds, 20 lbs. ensilaged Sugar-Beet Leaves and Tops, plus concentrated foods and hay.

The question as to the value of the residual Sugar-Beet Slices or Pulp for feeding to stock in this country was from the first recognised as being of the utmost importance, and accordingly large quantities of this food-stuff were purchased by The National Sugar-Beet Association, and extensive trials have been carried out in conjunction with Agricultural Colleges and the Norfolk Agricultural Station, with fattening beasts and dairy cows, to demonstrate the value when compared with Swedes and Mangolds.

The information that has come to hand up to the present points to two outstanding features:—

(1.) *That Sugar-Beet Pulp has given superior results over Swedes and Mangolds when fed to fattening beasts.*

(2.) *That the milk production is equal, and the resulting butter is firmer and has a better colour when made from pulp-fed cows as compared with cows fed on Mangolds.*

All other foods are alike for both lots of animals in each trial.

The proportion of the dried Sugar-Beet Pulp to Mangolds is 1 lb. of pulp to 8 lbs. of Mangolds.

This ratio has been fixed on a scientific and practical basis.

A special report will be issued on these feeding trials.

Analysis of Dried Sugar-Beet Pulp. *Wet Pulp.* *Mangolds.*
Carbohydrates or fat formers, 64% of which
5 to 7% is sugar 10 % .. 9.2%
Albuminoids or flesh formers 8% 1.3% .. 1.1%
Water, 6% to 7%

100 lbs. of Sugar-Beet yield 50 to 70 lbs. of wet pressed pulp, which is equal to about 5 to 7 lbs. of dry pulp or slices.

100 lbs. Mangolds contain 1 lb. albuminoids and 9 lbs. carbohydrates.

100 lbs. Swedes contain 1.25 lb. albuminoids and 7 lbs. carbohydrates.

10 lbs. Sugar-Beet Dry Pulp contain 1 lb. albuminoids and 7 lbs. carbohydrates.

COSTS AND RETURNS PER ACRE.

The yield, of course, would vary according to circumstances; but assuming normal conditions and proper treatment, a yield of 13 tons might be looked for on the average.

SUGAR-BEETS.		MANGOLDS.		SWEDES & TURNIPS.	
	£ s. d.		£ s. d.		£ s. d.
13 tons washed, topped and delivered at £1 ...	13 0 0	28 tons topped, tailed, cleaned, and sliced, at 7/6 per ton ...	10 10 0	15 tons at 5/- if fed in yards or say 250 sheep for one week at 30/- per 100 = 75/-.	3 15 0
Value of portion of beet-pulp returned free, say 15/- ...	0 15 0			Manual value after sheep and value of treading land, say ...	1 0 0
Free seed, say 20 lbs. at say ...	0 7 0				
Value of portion of lime returned free ...	0 3 0				
	15 0 0		10 10 0		4 15 0
Total cost of producing crop and delivering to factory (this could often be less) ...	12 0 0	Cost of producing crops, including topping, tailing and shicing ...	10 10 0	Cost, say £6 10s.	6 10 0
Net cash profit as soon as roots have been delivered, say in October or November ...	£3 0 0	Profit ...	Nil	Loss ...	£1 15 0

The average yields of above crops, as stated by the Board of Agriculture and the German Authorities, are:—Sugar-Beet: Germany, 12 tons. Mangolds: England, 20 tons. Swedes and Turnips: England, 14 tons. My valuation of 7/6 per ton for Mangolds is based on

two years' trials carried out with fattening beasts on Roots v. a Sugar Food, at Wye, Agricultural College, Kent. The sugar food cost £5 per ton, and 1lb. gave the same results as 14lbs. Mangolds both as to weight and cash returns. The foregoing figures can be altered according to the district; and, therefore, must be read in an explanatory sense, and not as a hard and fast rule.

THE INDIRECT PROFITS.

Sugar-Beet culture will help to raise the standard of farming wherever it is grown extensively for a factory.

Such, undoubtedly, has been the result in the great Sugar-Beet areas of Germany and other countries, higher yields of other crops, more head of stock per acre, increased value of land, and the general prosperity of the whole countryside has followed in the wake of the Sugar-Beet.

In quoting some figures given me by the Director of one of the Imperial Farms in Austria, let me say that careful records have been kept of yields of crops before and since the erection of a Sugar-Beet Factory on the Estate some 50 years ago. Since the introduction of Sugar-Beet one-third of the area of a 1,000 acre farm has been devoted to this crop, and thus is not available for cereals. They get, however, an equal aggregate yield of straw crop and grain to that obtained when a much larger area was devoted to these straw crops; also, whereas 40 cows were kept, 200 are now kept on the same area. These statistics do not bear exact relation to our farming, because, to a certain extent, mangolds have already influenced our farming in the same direction; but such facts go to show that our country and nation would very largely benefit.

This improvement is already being seen by farmers who have cultivated Sugar-Beet for a few seasons in this country, and they find it makes a splendid preparation crop for wheat and potatoes. One meets with instances in Germany and France where large tracts of waste sandy lands have been brought under the plough, and are now being successfully farmed through the beneficial effects of Sugar-Beet culture. Land that was practically valueless is now let and farmed to the benefit of the tenant, the landlord and the whole community.

The reason is that Sugar-Beet is the best cleaning fallow crop in existence. Humus is maintained in the land by applications of dung and the large quantities of root fibres that are left after removal of the crop. The minerals that are removed by the crop are nearly all returned to the land by feeding the pulp and leaves, or ploughing the latter in, and by the return of the factory lime. The sugar which is retained by the factory is manufactured in the leaves from carbon-dioxide (carbonic acid gas) from the air and water from the soil, and therefore does not in any way rob the soil. The deep rooting

nature of Sugar-Beet (the root system penetrates to a depth of several feet) helps to open up the subsoil, and, by disintegration and aeration, gradually brings a larger area into a condition suitable for plant life.

One is constantly asked why the English farmer should not carry out this deep and thorough tillage with his present crops. The answer is that it is simply a matter of £ s. d. The Sugar-Beet farmer fully realises the value of careful cultivation; but he also knows that at the end of the season he will receive a prompt cash return. His money is turned over quickly, and he can purchase beet pulp and other foods and go on feeding stock in the same way as the farmer who grows ordinary roots, and consequently he can turn his money over twice. Having cash to go on with, he is not obliged to rush his corn crops on the market, as is too often the case. The swede and turnip grower, feeding his roots to sheep or other stock, has to wait some time before he gets his money back, and then it is very problematical as to whether there is a profit or a loss.

This point is a very important one. The farmer who is growing 10 acres of ordinary roots may sink from £60 to over £100 of money in his cleaning operations, &c., and will have to wait, as a rule, until the spring before he gets his money back. The Sugar-Beet grower on the other hand, will have something like £130 gross, plus feeding stuff returned to him in October or November.

As Sugar-Beet will probably be grown and fed in conjunction with our ordinary root crops, it may be looked upon as being an *Auxiliary Cash Crop*, which will not replace highly lucrative crops; but which will, at all events, partly take the place of the least paying crops in the rotation.

All European countries, except our own, cultivate large areas of land for Sugar-Beet. The labour is usually anything but cheap, and the rent in the good beet areas averages from £2 10s. to £5 per acre.

In Holland there are something like 130,000 acres of Sugar-Beet grown annually against 50,000 acres of mangolds.

Free Trade is in existence, and the farmers are not tied up or obliged to grow Sugar-Beet when they renew their contracts.

They have a great dairying industry; and, therefore, know full well the value of Mangolds. Why is it that they grow more extensive areas of Sugar-Beet than Mangolds? There can only be one answer—and that is, that it pays them to grow Sugar-Beet.

In conclusion, may I draw attention to a perfectly obvious fact? Factory owners *must* make the growing of Sugar-Beet pay the farmer, otherwise the farmer will refuse to grow. It is a great industry that is dependent on Agriculture, and the profits and benefits must be, and surely are, mutual.

A CO-OPERATIVE SUGAR FACTORY IN HOLLAND.

"HOME COUNTIES."*

This article appeared in The Journal of The Board of Agriculture for March, 1912, and is reprinted by kind permission of The Controller of His Majesty's Stationery Office.

The first co-operative sugar factory which was established in Holland is in Zeeland, at Sas van Gent. In 1909-10 it worked up 47,600 tons of beets, and in 1910-11 some 53,000 tons. It paid 23s. 1d. per ton in the former campaign, and 24s. 2d. in 1910-11. The sugar percentage in the one campaign was 16.27, and in the other 17.16. The beets handled daily averaged 780 tons in 1909, and 800 tons in 1910. The factory's capital consists of 900 shares of about £33 each, on which about £8 is paid. They are practically all held by farmers. The minimum quantity of beets that may be sent in per share is 15 tons, and the maximum 30 tons.

The most modern co-operative factory in Holland is situated at Dinteloord. The order for this factory was given to the contractors on January 9th, 1909; building began in February, and the factory was making sugar on October 13th in the same year.

The figures in the following table show the results of its working in the three seasons during which it has been in operation:—

	1909-10.	1910-11.	1911-12.
Beet handled in season...	65,000 tons	87,000 tons	119,000 tons
" daily ...	1,098 "	1,333 "	1,400 "
Price	21s. 8d. per ton	25s. 1d. per ton	28s. 4d. per ton
Members	644	704	720
Shares	3,150	3,368	3,430

Some three hundred of the members have only a single share each. In 1909-10 the quantity of beets received per share was 21 tons; in 1910-11, 26 tons; and in 1911-12, 34 tons, the maximum allowed being 35 tons.

On the original 3,000 shares the farmers paid £8 4s. per share, making a total of £25,000. Four per cent. must be paid on this. The cost of the factory was £135,000. The balance was found by means of "shares, mortgages, bankers and members."

The farmers are justifiably proud of their up-to-date factory. Its manager is the son of the late manager of the biggest sugar factory in the country, the premises of which adjoin the co-operative enterprise at Dinteloord. The factory is to be enlarged at a cost of from £10,000 to £14,000 to a total capacity of 1,700 tons daily, and may therefore become the biggest sugar factory in Holland.

I found about 3,000 tons of beet piled up outside the factory, the stacks reaching as high as the houses that had been built for the accommodation of the director, chemist, accountant, and engineer, for in a "campaign" which goes on day and night all responsible persons must be on the spot. One of the three electric cranes is alone capable of transferring 400 tons of beets in a day from the barges to the concrete slopes of the storing place. There were convenient facilities for weighing both the railway and the farm wagons of beet, before and after their loads were shot out. The weight of the barges is also taken before and

after unloading by calculating displacement. In order to estimate a consignor's sugar percentage a sample is taken of every four tons lifted out of the barges, of every single wagon load when the beets are received by rail, and of every eight loads when they arrive by road.

As the novice never realises the quantity of water needed by a big sugar factory, it may be mentioned that at Dinteloord some 1,200 tons a day are used. The daily consumption of lime is 42 tons. Coal costs nearly 9d. per ton of beets. The "campaign"; staff, which numbers about 500 for day and night shifts, receives about £5,600 in wages. This does not include the pay of the heads of the factory or the office staff. As it is seldom that one hears of an estimator of the cost of an English factory saying anything about the expense of keeping the place in order when it is not working, it is worth noting that at Dinteloord, without counting head officials and the office staff, there are sixty men on the place after the sugar-making is over.

The shareholders receive wet pulp. Most of them live close at hand, so that they prefer wet slices to dry, but the factory tries to squeeze out as much water as possible.

I was assured that only three out of the twenty-five joint stock sugar factories in the Netherlands pay for beets according to the percentage of sugar in the same way as the co-operative ones do. After the season of 1910-11 Dinteloord paid off more than £4,000 in redemptions. As a result of this season (1911-12) it will probably carry more than £20,000 to reserve, and the members will be paid about 8s. 4d. more per ton for their beets than they would have got, so I was informed, from the joint stock companies.

The co-operative factory struck me as frugally but efficiently planned. The co-operators reduce the amount of their machinery by contenting themselves with the production of an unrefined white sugar. It is thought that this is more profitable than refining, which means increased capital, a higher excise duty, and finding trade customers. Everyone who has thought about these considerations attaches weight to them, though an experienced sugar firm may well find a great advantage in refining as well as in simply making sugar.

Dinteloord has been happy in the time of its starting. After the Sas van Gent factory was started sugar prices went down; since Dinteloord's first season prices have kept going up. The managing director laid the greatest stress on the help this had been. If old hands in sugar beet culture, not unacquainted with sugar manufacture, attach importance to such a piece of good fortune, how necessary it is that English factory promoters should be far-seeing and cautious. When I went over the Dinteloord factory in November most of the sugar had already been sold at good prices in advance of manufacture.

From the farmers' point of view the co-operative factory is no doubt the ideal way of going to work: the agriculturist gets his profits as a beet grower and his dividend as a sugar manufacturer.

The managing director of the Dinteloord factory, who has large farming interests in Zeeland, told me that he would obtain 43 tons of beet per hectare (2½ acres), over an area of 118 hectares. He reckoned in fact that his crop would be over 5,000 tons. The analysis of his first cargo to arrive at the factory reached the high sugar percentage of 19.3, and in later cargoes he had touched 17 and higher, but he said, "now the rain has come I may be down to 16 per cent." The highest sugar percentage is obtained after wheat, and the least after clover and green manure. The English farmer who reads this should remember, of course, that this is experienced culture on highly suitable land.

*Author of "Sugar Beet: Some Facts and Some Allusions." Published at "The Field" Office, Breems Buildings, W.C. Price 6/- Net.
The most complete and impartial work on this question published in the United Kingdom.

THE PRODUCTION OF BEET SUGAR IN A CONTINENTAL FACTORY.

R. N. DOWLING, N.D.A.

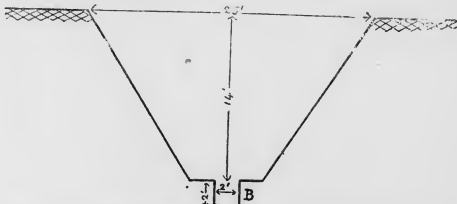
This article appeared in The Journal of The Board of Agriculture for March, 1912, and is reprinted by kind permission of The Controller of His Majesty's Stationery Office.

A factory generally starts its "campaign," or season, as soon as the beets are ripe enough. This is often as early as the middle of September on the Continent; and to induce farmers to send their roots earlier or later than the majority, it is not unusual for a factory to offer a rather higher price, as it is very necessary that the supply should be regulated. This question is only vital where very sharp frosts are experienced before Christmas. Badly frosted beets can be worked up if taken before the thaw sets in, but after this they become "woolly" and soft through the bursting of the cells, and are then liable to give trouble in the factory.

DELIVERY, WEIGHING AND SAMPLING OF ROOTS.—The delivery of the "roots" takes place by road, rail, or water. The wagons or railway trucks are weighed over a weighbridge both before and after unloading, and it is the usual custom for sample quantities of about one to two bushels to be taken from the wagons of each farmer for a few days at the beginning and at intervals during the "campaign." These are weighed, washed and re-weighed, in order to ascertain the amount of "tare" to be deducted, which usually amounts to from 10 to 20 per cent. Sample roots are also analysed for their sugar content by means of the polarimeter.

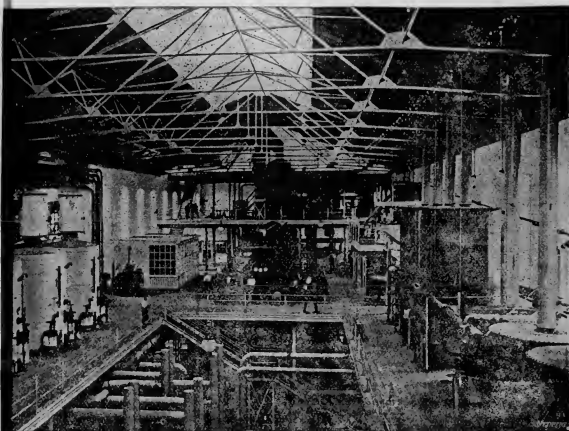
DISPOSAL OF ROOTS AT THE FACTORY.—The wagons are drawn up alongside the "flumes" or open channels and unloaded mechanically by means of hydraulic levers under the railway trucks, or by hand-forks. The latter is much the more common method.

The "yard" of a modern factory is divided up into long parallel channels or pits, which are about 100ft. (more or less) in length, 20ft. to 30ft. wide, and 4ft. to 15ft. in depth. The pit is built of brick or concrete with a "flushed" surface, and its sides slope, so that at the bottom it is only a few feet across. An open channel (see *B*) runs down the middle, having a width and depth of about 2ft. Iron plates are laid across the top of the gutter *B*, except where the beets are allowed to fall into it. Water rushes along this gutter, and thus floats them towards the factory.

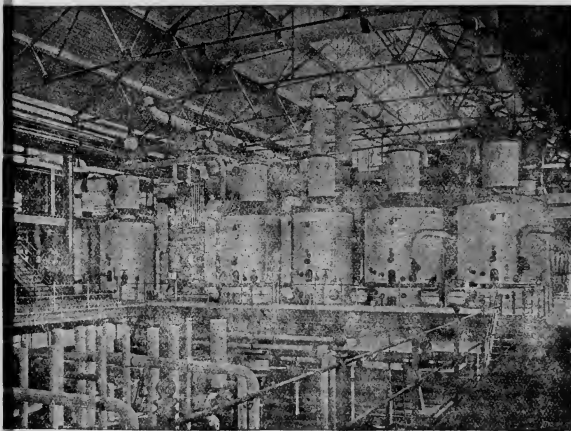


CHANNEL ALONG WHICH BEETS ARE FLOATED TOWARDS THE FACTORY.

Reproduced by kind permission of Messrs. BREITFELD, DANBK & Co.



SUGAR FACTORY.—General View as seen from the Vacuum Pans.



EVAPORATING PLANT.

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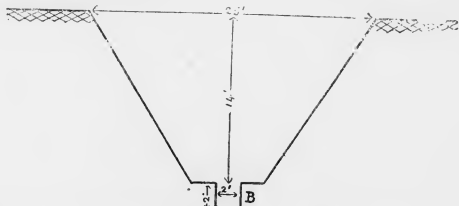
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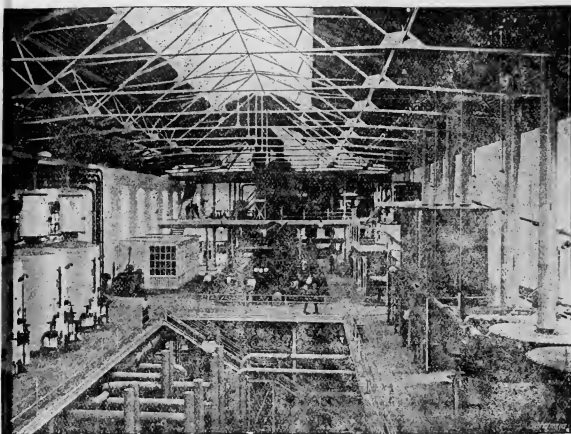
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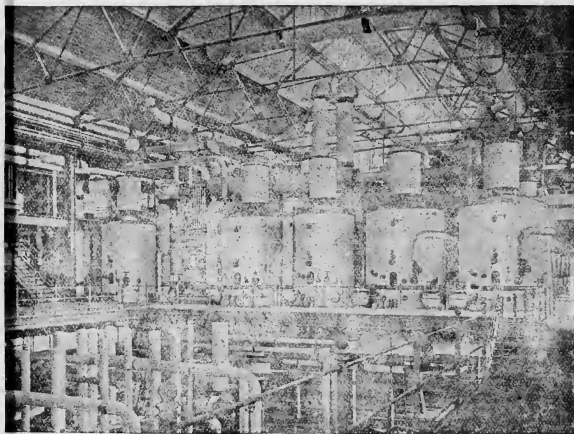


CHANNEL ALONG WHICH BEETS ARE FLOATED TOWARDS THE FACTORY

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SUGAR FACTORY.—General View as seen from the Vacuum Pans.



EVAPORATING PLANT.

In this way hundreds of tons of "roots" can be unloaded into this pit continuously. It is also possible to regulate the quantity falling into the gutter.

WASHING.—As a rule, the beets have to be lifted to a higher level before entering the washing machine. This lifting is done by means of a scoop wheel or chain elevators, revolving screw "worms," or by the more modern "mammoth" pumps. The "mammoth" pump consists of a U-shaped iron cylinder, having one arm longer than the other. The beets flow into the shorter arm with water, both being gradually raised into a spout, and thence into the washing machine by means of the compressed air in the long arm of the U tube, which is provided from a compressor.

The horizontal beet-washers are fitted with a revolving shaft having iron arms, which keep the mass constantly on the move towards the elevator at one end. The trough is fitted with stone catchers.

WEIGHING.—The beets are next raised by a bucket or chain elevator to the top of the factory and discharged into an automatic weighing machine holding about 800lbs. This machine records accurately the washed weight of all the beets passing through the factory, and in this way a check is obtained both on the outside weighings and on the sugar yield.

SLICING.—As soon as the known weight of beets is reached the basket tilts automatically, and its contents are delivered by gravitation into hoppers, and thence into rapidly-revolving cutting or slicing machines. These machines have horizontal plates or discs fitted with sharp fluted blades or knives, which revolve at a great rate and cut the beet into slices known as "*Schnitzel*." The knives have constantly to be removed for sharpening.

The slices are regular in shape, being about 3 to 4 inches long by one-eighth of an inch in diameter.

THE EXTRACTION OF THE SUGAR BY THE DIFFUSION PROCESS.—After leaving the "slicer" these slices are conveyed to the diffusers by means of a travelling rake conveyor and shoots. The diffusion battery consists of a number of iron cylindrical cells or diffusers, which may hold as much as five or more tons of slices, and are fitted with valves to regulate the supply of hot juice and water, and also with a moveable cap top and bases for filling and emptying.

The hot juice and water is forced by pressure through the diffusers and the process of extracting the sugar by diffusion is set up. The hot juice is run from one diffuser to another, and after going the whole round of the battery it is drawn off and conveyed into centripetal cylindrical strainers, after which it is measured automatically, heated in pre-heaters, and forced into the lime mixers to be mixed with quicklime which has been prepared from the kiln outside, whereby it is purified or defecated.

PURIFICATION OF THE JUICE.—A chemical reaction and a mechanical action take place, the lime helping to precipitate and decompose the non-sugars, and to carry suspended organic bodies down with it. This defecation may take place in a separate vessel or in the carbonation tank.

Carbonation is brought about by driving carbon dioxide into the defecated or purified raw juice by means of pumps. This causes the formation of calcium carbonate, etc., which form a precipitate. After this first carbonation, or saturation of the juice with CO₂, it is pumped up to the filter presses which separate the suspended precipitate and the partly purified juice. This treatment is repeated in a second carbonation tank and filter press, and sometimes a third, where the alkalinity of the juice is finally adjusted.

The residual lime-cake is conveyed by means of transporters to a heap outside, and eventually is given to the farmers or sold for about 3s. a ton. It contains:—

0.46	per cent.	Potash (K_2O).
1.28	"	Phosphoric acid (P_2O_5).
1.22	"	Magnesia.
9.25	"	Calcium carbonate.
21.23	"	Organic matter (fine beet rootlets, &c.).
50.00	"	Water.
16.56	"	Other constituents.

100.00

The purified thin juice passes on to the evaporators in order to evaporate some of the water (about 80 per cent. of juice weight) and convert the thin juice from about 13° Brix. into a thick juice having a density of about 60° Brix. In order to effect this operation economically the evaporation system is based on the principle that the latent heat is used over and over again, in modern factories generally four or five times. The evaporating pans are arranged in series, and the first vessel is heated either by direct steam, exhaust steam, or high pressure vapour from a juice pre-boiler; the exhaust steam or vapour is condensed after parting with its heat to the juice or liquor in the first vessel.

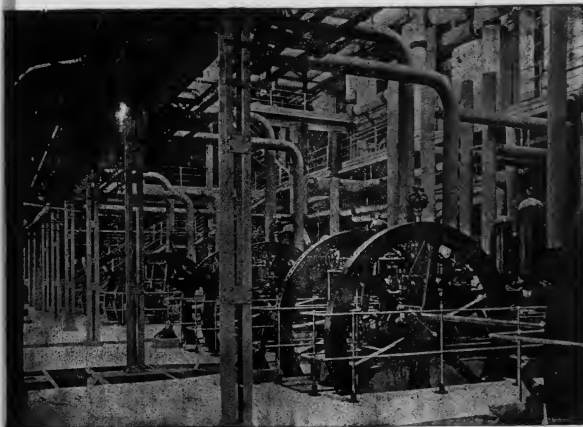
The vapour which is given off from the juice thus heated now passes into the heating chamber of the second vessel, where it in its turn is condensed and gives off its heat to the juice in this vessel. The same process is repeated in the third and fourth vessels.

The vapour from the fourth vessel now passes, as a rule, through juice heaters where as much as possible of its remaining heat is utilised. It then passes on to the condenser. This vapour is at a very low tension. In order to maintain a vacuum in the condenser it has to be provided with an air-pump to draw off all incondensable gases, which are always more or less mixed with the vapour, and which would otherwise accumulate in the condenser. It will be seen that 1lb. weight of steam (as measured in a closed vessel) evaporates nearly its own weight in each of these vessels, *i.e.*, it has almost a fourfold economy.

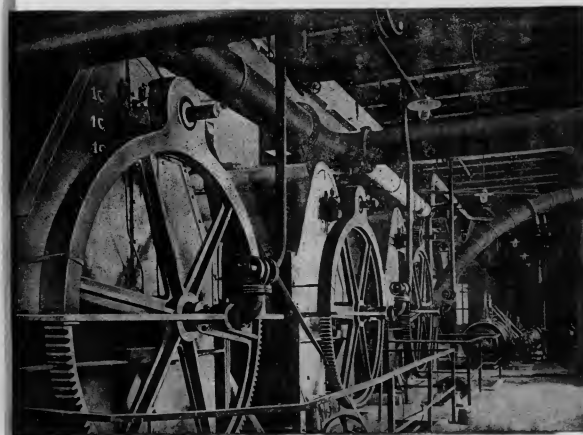
The thick juice from the evaporators is pumped to another carbonation or sulphitating installation and after treatment is again filtered and passed on to the vacuum-pan supply tank, and thence to the vacuum-pans.

This final evaporation of the concentrated juice in the vacuum-pans is also performed in a comparatively high vacuum in order that the sugar may boil at a very low temperature, and thus not subject the crystals to caramelisation or "burning." The vapour issuing from the vacuum-pans is also condensed in a condenser provided with an air-pump.

In most modern factories there is only one condenser in the whole factory, which serves for both the evaporators and vacuum-pans. This thick juice in the vacuum-pans is boiled until it reaches a condition known as "massecuite," *i.e.*, a mixture of well-defined crystals and concentrated syrup. This "massecuite" is now discharged into crystallisers, where it is cooled down by stirring, thus allowing the "grain" to grow, and it is afterwards passed to the centrifugals, which by the rapid revolving action separate the crystals from the adhering syrup, the latter passing through the finely-perforated periphery, leaving the crystals of sugar adhering to the sides of the centrifugal basket.



VIEW OF ENGINE ROOM.



BEET-SLICE DRYERS.

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1.22	"	Magnesia.
9.25	"	Calcium carbonate.
21.23	"	Organic matter (fine beet rootlets, &c.).
50.00	"	Water.
16.56	"	Other constituents.

100.00

The purified thin juice passes on to the evaporators in order to evaporate some of the water (about 80 per cent. of juice weight) and convert the thin juice from about 13° Brix. into a thick juice having a density of about 60° Brix. In order to effect this operation economically the evaporation system is based on the principle that the latent heat is used over and over again, in modern factories generally four or five times. The evaporating pans are arranged in series, and the first vessel is heated either by direct steam, exhaust steam, or high pressure vapour from a juice pre-boiler; the exhaust steam or vapour is condensed after parting with its heat to the juice or liquor in the first vessel.

The vapour which is given off from the juice thus heated now passes into the heating chamber of the second vessel, where it in its turn is condensed and gives off its heat to the juice in this vessel. The same process is repeated in the third and fourth vessels.

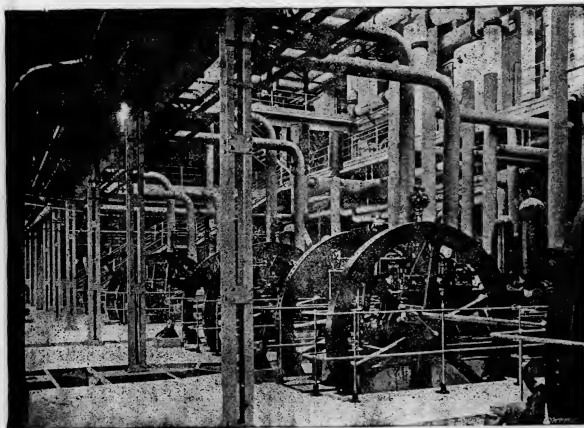
The vapour from the fourth vessel now passes, as a rule, through juice heaters where as much as possible of its remaining heat is utilised. It then passes on to the condenser. This vapour is at a very low tension. In order to maintain a vacuum in the condenser it has to be provided with an air-pump to draw off all incondensable gases, which are always more or less mixed with the vapour, and which would otherwise accumulate in the condenser. It will be seen that 1lb. weight of steam (as measured in a closed vessel) evaporates nearly its own weight in each of these vessels, *i.e.*, it has almost a fourfold economy.

The thick juice from the evaporators is pumped to another carbonation or sulphitating installation and after treatment is again filtered and passed on to the vacuum-pan supply tank, and thence to the vacuum-pans.

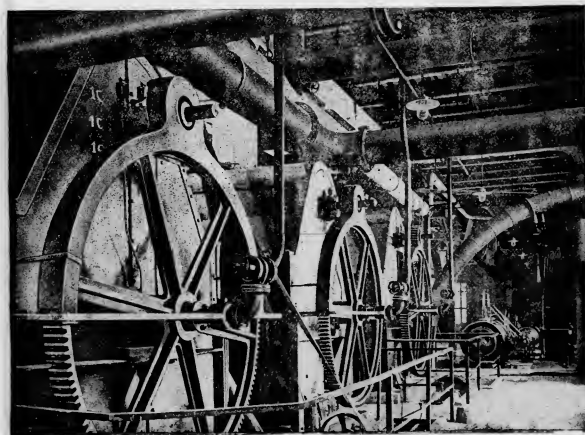
This final evaporation of the concentrated juice in the vacuum-pans is also performed in a comparatively high vacuum in order that the sugar may boil at a very low temperature, and thus not subject the crystals to caramelisation or "burning." The vapour issuing from the vacuum-pans is also condensed in a condenser provided with an air-pump.

In most modern factories there is only one condenser in the whole factory, which serves for both the evaporators and vacuum-pans. This thick juice in the vacuum-pans is boiled until it reaches a condition known as "massecuite," *i.e.*, a mixture of well-defined crystals and concentrated syrup. This "massecuite" is now discharged into crystallisers, where it is cooled down by stirring, thus allowing the "grain" to grow, and it is afterwards passed to the centrifugals, which by the rapid revolving action separate the crystals from the adhering syrup, the latter passing through the finely-perforated periphery, leaving the crystals of sugar adhering to the sides of the centrifugal basket.

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VIEW OF ENGINE ROOM.



BEET-SLICE DRYERS.

This first sugar has a polarisation of about 96 per cent. to 97 per cent. The syrup is again treated by boiling, etc., as before, and after passing through a second lot of centrifugals yields a sugar having a polarisation of about 90 per cent. The resulting syrup forms the by-product called "molasses" or agricultural treacle.

WASTE-WATERS OR "EFFLUENT."—The waste water that is pressed out from the used pulp, and also that from the diffusion battery, is liable to cause trouble by giving off noxious gases produced by the fermentation of the organic matter. To avoid this the water is usually treated with lime and an iron salt, and then allowed to run out into a series of "settling ponds," together with the water from the "washer," etc. After being allowed to remain for about three days in one pond or basin the water is run into a second, and so on until a fairly pure liquid is obtained. It is sometimes then run across a meadow and into a stream.

THE "STEFFEN" PROCESS.—Factories fitted with this patent process differ from the ordinary ones in having the diffusion battery replaced by a trough fitted with a revolving screw, by means of which the slices are slowly moved through the trough while in contact with hot water or hot raw juice. This is known as "hot infusion." Not so much sugar is extracted, but the advantages claimed are:—

- (1.) That the initial outlay is less.
- (2.) That the resultant dry slices contain 30 per cent. to 35 per cent. of sugar instead of 5 per cent. to 6 per cent. in the ordinary slices, and therefore a higher price can be charged the farmer per ton.
- (3.) That the working expenses are less, because it is the last portion of the sugar that is the most difficult to obtain and crystallise.

It is sometimes worked in conjunction with the diffusion battery, and the manufacturers informed the writer that the extra cost was about £7,500 for a 600-ton factory. In this way it is claimed that almost the whole of the sugar can be extracted. If sugar is cheap the "Steffen" process can be used alone. Very few factories seem to be fitted with this process, however, and it does not seem to be popular at present. A well-known authority in Germany informed the writer that the price asked for the "Steffen slices" was too high in proportion to their actual feeding value, and that in practice the extra sugar did not give such good results as might be expected because of the digestible nature of the carbohydrates present in the ordinary slices, which only contain about 5 per cent. to 6 per cent. of sugar.

HEAT IN FACTORIES.—The old buildings are often "cramped" for room and are badly ventilated. In such cases the atmosphere is hot and oppressive. A modern factory, however, is like one big hall, excellently ventilated and by no means objectionable, and the so-called "obnoxious odour" is a fallacy. The writer stayed at different factories, and did not experience any such unpleasantness.

The following data relate to a German factory dealing with 1,200 tons of beet in the 24 hours (unless otherwise stated), and were given to the writer by the manager.

WATER.—The purer the supply the better it is. Soft water is preferable to hard, but it is not a *sine qua non*. The quantity required for floating the beets in and washing is about 1,100 gallons per minute. For the diffusion battery 250 per cent. of the weight of roots is wanted if entirely fresh water is used. If part of the water is purified and used over again, it is possible to do with 120 per cent.

In another factory in Bohemia of 1,000 tons capacity, 1,500 gallons of water per minute (about 7 cubic metres) were required, which is equivalent to 9,640 tons of water every 24 hours.

COAL.—Brown coal is generally used on the Continent. About 6 per cent. of beet weight would be required when using English coal of fairly good quality. Thus for a 1,000 ton factory about 60 tons of coal would be required every 24 hours.

LIMESTONE.—About 4 per cent. of the beet weight is required. Therefore 40 tons would be used every 24 hours in a 1,000 ton factory.

NUMBER OF "HANDS."—In this 1,200 ton factory 270 men are at work during the factory season, but only about 80 in the summer. The remainder work on the land or at other industries, such as brick-making, when not required in the factory.

WAGES.—Staff in the factory: Manager, £500 to £750 per annum; two chemists, £100 to £150 per annum; one engineer, £125 to £150 per annum; one assistant, £125 to £150 per annum; two book-keepers—1st, £200 to £250 per annum; 2nd, £125 to £150 per annum.

In addition to the salary, the manager generally has a house, and the staff have free lodgings, light and heat.

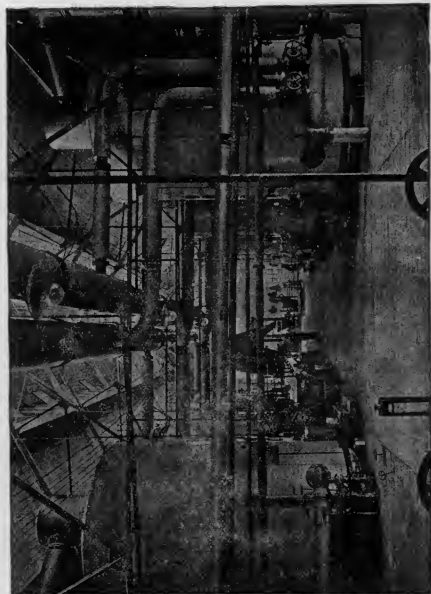
UNSKILLED LABOUR.—The men get 4s. to 5s. a day.

BEETROOTS.—The cost to the factory of one ton delivered and everything included varies from about £1 to 25s. Cost of working same per ton is about 6s.

BET-SUGAR FACTORY AT DINTELOORD, HOLLAND.—This new factory is most interesting not only with regard to its modern building and machinery, but also to the fact that it is a co-operative concern and entirely run by farmers.

WORKING ACCOUNT OF THE SEASON, 1910-11.

<i>Received:—</i>		
Net proceeds, sugar	...	£ 146,920
" pulp	...	8,185
" molasses	...	3,983
Sugar beets lost and covered by insurance and proceeds of beet sold...		127
Balance on shares and direct receipts	...	110
Total	...	£153,326
<i>Less Costs of Working:—</i>		
Depreciation	...	6,036
Maintenance	...	4,285
Factory materials	...	5,473
Wages	...	3,289
Salaries and allowances	...	1,349
General expenses	...	1,349
Interest	...	509
Cost of receiving beets, freights, wages, controller's account...		10,438
		32,628
Balance of working account	...	120,698
Fines received	...	11
Total	...	£120,709
<i>Less Charges under Art. 21 of Association:—</i>		
Interest	...	£ 3,700
Redemptions	...	4,000
Dividends 4 per cent. on capital paid up	...	1,050
Fire insurance	...	182
		8,932
Paid to members supplying sugar-beet	...	£111,777
		111,461
Still to be paid	...	£316
		316



VACUUM FANS.

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VACUUM PANS.

BALANCE-SHEET OF BEET-SUGAR FACTORY AT DINTELOORD, HOLLAND, FOR THE YEAR ENDING MARCH, 1911.

ASSETS.				LIABILITIES.			
		£	£			£	£
<i>Engines</i> .. .. .	.. .. .	64,907	59,383	Subscribed Capital.. .. .	.. .. .	111,167	
Depreciation last year .. .. .	.. .. .	2,772	5,574	Less to be paid up in case of need.. .. .	.. .. .	83,375	27,792
" this " .. .. .	.. .. .	2,802					
<i>Buildings</i> .. .. .	.. .. .	41,599	7,613	First mortgage 5 per cent. obligations.. .. .	.. .. .	75,000	
Depreciation last year .. .. .	.. .. .	1,248	2,692	" 5 " redeemed .. .. .	.. .. .	3,580	71,420
" this " .. .. .	.. .. .	2,558					
<i>Electrical Installation</i> .. .. .	.. .. .	3,753	3,400	Second mortgage 5 per cent. obligations .. .. .	.. .. .	25,000	
Depreciation last year .. .. .	.. .. .	178	363	" 5 " redeemed .. .. .	.. .. .	415	24,585
" this " .. .. .	.. .. .	175					
<i>Laboratory</i> .. .. .	.. .. .	571	581	Creditors .. .. .	.. .. .		2,574
Depreciation last year .. .. .	.. .. .	20	40	Deposits .. .. .	.. .. .		0,617
" this " .. .. .	.. .. .	20		Interest on obligations during three months .. .. .	.. .. .		1,200
<i>Office Furniture</i> .. .. .	.. .. .	242	231	Costs .. .. .	.. .. .		280
Depreciation last year .. .. .	.. .. .	4	11	Balance still to be paid under Art. 26 of the regulations .. .. .	.. .. .		317
" this " .. .. .	.. .. .	7		Sugar carriage, insurance .. .. .	.. .. .		38
<i>Quay</i> .. .. .	.. .. .	1,638	1,924	Coupons of Load due and unpaid .. .. .	.. .. .		2
Depreciation last year .. .. .	.. .. .	57	114				
" this " .. .. .	.. .. .	57					
<i>Vessels</i> .. .. .	.. .. .	612	564				
Depreciation last year .. .. .	.. .. .	24	48				
" this " .. .. .	.. .. .	24					
<i>Railway</i> .. .. .	.. .. .	2,757	2,585				
Depreciation last year .. .. .	.. .. .	111	222				
" this " .. .. .	.. .. .	111					
<i>Implements</i> .. .. .	.. .. .	3,694	3,275				
Depreciation last year .. .. .	.. .. .	211	419				
" this " .. .. .	.. .. .	208					
<i>Bags</i> .. .. .	.. .. .		122				
" this " .. .. .	.. .. .		166				
<i>Cloths</i> .. .. .	.. .. .		333				
<i>Chalk</i> .. .. .	.. .. .		91				
<i>Cakes</i> .. .. .	.. .. .		750				
<i>Coal</i> .. .. .	.. .. .		3,750				
<i>Molasses</i> .. .. .	.. .. .		1,570				
<i>Sugar beet seed</i> .. .. .	.. .. .		1,802				
<i>Stores</i> .. .. .	.. .. .		50				
<i>Timber</i> .. .. .	.. .. .		15				
<i>Debtors</i> .. .. .	.. .. .		73				
<i>Buyers of sugar</i> .. .. .	.. .. .		49				
<i>Shareholders</i> .. .. .	.. .. .		59				
<i>Cash</i> .. .. .	.. .. .		10,733				
<i>Bankers</i> .. .. .	.. .. .		727				
<i>Premium of insurance paid in advance</i> .. .. .	.. .. .		1				
<i>Balance on shares still to be received</i> .. .. .	.. .. .						
			<u>£137,820</u>				<u>£139,850</u>

Some 700 farmers are shareholders, and 3,430 shares of £36 each have been taken up. Of these farmers about 300 are "small-holders," and have taken one share each, one-fourth being paid in cash and the balance in roots. A large sum was borrowed, but this must be cleared off in 25 years.

A shareholder contracts to provide the factory with a minimum of 15 tons and a maximum of 35 tons of roots per share. About 119,000 tons of beet were worked up during the past season. The total in 1910-11 was 87,000 tons. In 1910 the average sugar percentage was 17.54, the highest 20.4, and the lowest 15.8 per cent., and the factory was able to pay as much as 25s. per ton, including profits, after making extensive allowance for depreciation, paying 4 per cent. on capital, and redeeming £4,000 of the mortgage.

A copy of the working account and balance-sheet for the year ending March, 1911, is given on the previous pages.



REPORT

OF

EXPERIMENTS ON FEEDING SUGAR-BEET SLICES TO FATTING CATTLE AND MILCH COWS.

By R. N. DOWLING, N.D.A., Agricultural Adviser.

The feeding value of the dried and wet residual sugar-beet slices after the sugar has been extracted at the factory is well-known on the Continent; but in order to be able to place first-hand information on this point before the English farmer and others interested, arrangements were made by the National Sugar-Beet Association to supply dried slices free of all cost to the following Institutions, and the Directors wish to thank the Principals and members of the Staffs of such Institutions for their help and superintendence of these trials:—

TRIALS WITH FATTING CATTLE.

- (1.) The Norfolk Agricultural Station, Little Snoring, Norfolk.
- (2.) The South-Eastern Agricultural College, Wye, Kent.
- (3.) The Harper-Adams Agricultural College, Newport, Salop.

TRIALS WITH MILCH COWS.

- (1.) The South Eastern Agricultural College, Wye, Kent.
- (2.) The Royal Agricultural College, Cirencester.
- (3.) The Department of Agriculture, University College, Reading.
- (4.) The Holmes Chapel Agricultural College, Cheshire.

The objects of these trials were:—

To test the value of sugar-beet slices as compared with swedes and mangolds.

- (1.) When fed to fating cattle.
- (2.) When fed to milch cows.

PLAN OF EXPERIMENTS.

In the case of both the fating beasts and milch cows the animals selected in each case were divided into two groups, each group being as near alike as possible in all respects.

One group was fed on mangolds or swedes, and the other received an equivalent amount of dried slices; all the other foods—hay, chaff, cake, &c.—were fed in equal quantities to both groups.

The amount of dried slices to be given was determined by the "starch equivalent" method, and it was calculated that 1lb. of ordinary dried slices was equivalent to 8lbs. of mangolds. This proportion has given very satisfactory results.

The following Reports are exact copies as sent in by the different Institutions:—

(1.) THE NORFOLK AGRICULTURAL STATION.

SUGAR BEET SLICES AS FOOD FOR CATTLE.

The feeding value of sugar-beet slices has been a subject of much enquiry during the last few years since the growing of sugar-beet in Norfolk became a reality.

In order to have first-hand information on this point, the Executive Committee of the Norfolk Agricultural Station determined to carry out a feeding trial during the past winter at their experimental farm at Little Snoring, near Fakenham. They were enabled to do this by the generosity of the National Sugar-Beet Association Limited, who presented free of cost five tons of dried sugar-beet slices. The Executive Committee also wish to acknowledge the advice and assistance they have received from time to time during the course of the experiment from Lord Denbigh, the Chairman of the Association, and from Mr. R. N. Dowling, the Association's expert.

The slices used were imported from the Continent, and on analysis were found to contain the ingredients shown in the following analysis:—

	Per cent.
Water	9.5
Crude Proteins	10.6 (A)
Carbohydrates	61.8 (B)
Fibre	15.3
Ash	2.8

100.0

(A) Containing 1.7 per cent. nitrogen. .

(B) Including 7 per cent. sugar.

The slices contained, therefore, 90.5 per cent. of dry stuff. The roots with which they were compared were swedes in the early part of the experiment, and mangolds at the finish. They contained on the average just over 11 per cent. of dry matter—that is to say, one-eighth of the amount contained in the slices. The rations used aimed at giving equal weights of dry matter in slices and roots; consequently 1 stone of slices were used for each rcwt. of roots.

The experiment lasted from January 8th to March 18th, a period of ten weeks. The rations consisted of 2lbs. common cotton cake, 2lbs. linseed cake, and as much chaff as the bullocks would eat. Ten bullocks received, in addition, rcwt. of roots; while the second 10 received 1 stone of slices, which were moistened some hours before being fed to the bullocks with about twice their weight of water, 14lbs. of slices requiring about 2 gallons.

During the first month of the experiment whilst the "roots" bullocks were on swedes, the "slices" bullocks made the greater increase in weight—20lbs. per head per week, as compared with 16lbs. per head per week. This was to be expected, as the swedes contained only 9 per cent. of dry matter, and rcwt. would correspond to about 11lbs. of slices. During the latter part of the experiment, whilst the "roots" bullocks were on mangolds, containing 12 per cent. of dry matter, they gained weight rather more rapidly than those on slices.

This, again, was to be expected, for rcwt. of mangolds, containing 12 per cent. of dry matter, should correspond to 16lbs. of slices, whereas 14lbs. only were fed.

On the average of the whole period the weekly gains per head were practically the same—13.6lbs. per head per week on slices, 13.1 lbs. per head per week on roots. The bullocks thrived well throughout the experiment, and the results may be taken as quite reliable.

CONCLUSIONS.

Prospective users of slices may take it *that slices are good food for fattening cattle as a substitute for roots*, and that 1 stone of ordinary slices of the composition quoted above is just about equivalent to rcwt. of ordinary mangolds, and rather better than rcwt. of swedes.

A full account of the experiment will be published later in the Annual Report of the Station.

T. B. WOOD,

*Professor and Principal of the School of Agriculture,
Cambridge University.*

25th April, 1912.

(2.) THE SOUTH-EASTERN AGRICULTURAL COLLEGE, WYE, KENT.

EXPERIMENT I.

WITH FATTENING CATTLE.

PLAN OF THE EXPERIMENT.

As the food to be experimented with takes the place of roots in the daily ration the plan of the experiment was that two groups of cattle should be selected, one group to get mangolds, the other to get an equivalent amount of the dried slices, all the other foods—hay, chaff, cake, etc., to be fed in equal quantities to both groups.

According to the starch equivalent method of food valuation, 1lb. of the ordinary slices was calculated to be equivalent to 8lbs. mangolds, and these foods were fed in this proportion throughout the experiment.

The cattle used were a lot of 10 Irish Shorthorn steers bought on October 19th, 1911. They were weighed and tied up in the stalls on October 28th, and for the next three weeks all received the same ration of roots, fodder and cake:—

Cabbages and Swedes	45 lbs.
Hay	5 "
Soya Cake	3 "
Eg. Cotton Cake	3 "
Oat Straw	ad. lib.

From November 4th to 20th all the steers received 2lbs. each of the beet pulp soaked in water and mixed with chaff, in order to accustom them to the food, and by the end of the preliminary period (November 28th), all ate the pulp, although a few were somewhat slow in taking to it.

On November 20th the steers were divided into two groups of five each of approximately equal weights, but this equality of numbers was upset in a few days by one of the steers in the control or mangold group developing a swelling at the brisket which prevented him feeding out of the trough; this steer was, therefore, removed from the experiment. It should be mentioned that although the two groups were approximately equal as regards live weights, the group allotted to the beet slices appeared to be slightly better "doers," and it was considered advisable to have whatever unavoidable difference there might be in this respect credited to this group, in order that no failure which might follow the use of the new food should be attributable to the animals.

The experimental feeding was commenced on November 20th, and the kinds and quantities of the various foods given are stated below.

CONTROL OR MANGOLD GROUP.

Date.	Mangolds.	Hay.	Hay and Straw Chaff.	Soya- Cake.	Dec. Cot.	Eg. Cot.	Molass- cuit.	Tracle.	Straw.
1911.									
Nov. 20	.. 56	8	6	4	-	4	-	-	<i>ad. lib.</i>
Dec. 2	.. 64	4	6-8	4	-	4	-	-	"
Dec. 16	.. 64	-	6-8	4	-	4	-	-	"
1912.									
Jan. 13	.. 64	4	6-8	4	-	4	I	-	"
Jan. 20	.. 64	4	6-8	5	-	5	I	-	"
Feb. 2	.. 64	4	6-8	-	5	5	I	$\frac{1}{2}$	"

SUGAR BEET SLICES GROUP.

Date.	Mangolds.	Beet Slices.	Hay and Straw Chaff.	Soya Cake.	Dec. Cot.	Eg. Cot.	Molass- cuit.	Tracle.	Straw.
1911.									
Nov. 20	.. 40	2 8	6	4	-	4	-	-	<i>ad. lib.</i>
Dec. 2	.. 40	3 4	6-8	4	-	4	-	-	"
Dec. 9	.. 32	4 4	6-8	4	-	4	-	-	"
Dec. 16	.. 24	5 -	6-8	4	-	4	-	-	"
1912.									
Jan. 1	.. 16	6 -	6-8	4	-	4	-	-	"
Jan. 13	.. 8	7 4	6-8	4	-	4	I	-	"
Jan. 20	.. -	8 4	6-8	5	-	5	I	-	"
Feb. 2	.. -	8 4	6-8	-	5	5	I	$\frac{1}{2}$	"
Feb. 19	.. 8	7 4	6-8	-	5	5	I	$\frac{1}{2}$	"

METHOD OF FEEDING.

The mangolds were fingered, mixed with hay and straw chaff, and fed three times a day; the long hay was fed at mid-day, and the long straw morning and evening; the cake morning and evening. The beet slices were soaked in water for 1-2 hours; then mixed with the mangolds and chaff, or with the chaff only when no mangolds were given, and fed three times a day.

The amount of water absorbed by the dried slices was approximately four times their own weight; 40lbs. slices absorbed 160lbs. water, and when more water was added a little trickle of moisture drained away from the heap.

All the animals had the offer of water once each day, and those receiving the slices consumed more than those in the mangold group, *e.g.*, average per head per day taken by the beet group, 5 gallons; by the mangold group, 3 gallons.

NOTES ON THE RATIONS.

It was expected that it would be possible to increase the quantity of beet slices more rapidly than the above table of rations shows, and also to do without hay, owing to the small supply available, but the increase of the pulp by 2lbs. per head per day, on one occasion resulted in scouring of several of the steers, so the slower rate of increase had to be resumed. In January it was necessary to use barley straw instead of oat straw for chaff, and this change made the mixture so much less appetising that molasscuit, and later on, treacle, had to be added to ensure satisfactory feeding. The slices mixture in this instance was apparently no more appetising than the mangold mixture, and both lots of bullocks cleaned up their food much better when the molasscuit and treacle were added. A small allowance of long hay was again introduced at this time. In February decorticated cotton cake was given in place of soya cake to both groups.

RESULTS.

CONTROL GROUP OF FOUR STEERS.

WEIGHT.

No.	When exp. commenced.	When sold.	Increase in lbs.	No. of days.	Increase per day. lbs.	Carcass weight %
I. . . .	10-1-20	11-3-0	148	149	1.00	61.3
II. . . .	9-3-16	11-0-0	124	127	.97	58.6
VII. . . .	10-2-8	11-2-10	114	142	.80	61.8
IX. . . .	10-2-24	12-0-21	165	100	1.65	58.9
Average . .	10-1-17	11-2-15	137 $\frac{1}{2}$	129 $\frac{1}{2}$	1.10	60.15%

SUGAR BEET SLICES GROUP OF FIVE STEERS.

WEIGHT.

No.	When exp. commenced.	When sold.	Increase in lbs.	No. of days.	Increase per day. lbs.	Carcass weight %
IV. . . .	10-1-22	11-2-23	141	106	1.33	59.5
V. . . .	10-0-16	11-2-10	162	113	1.43	59.6
VI. . . .	9-2-22	10-2-16	106	113	.93	58.6
VIII. . . .	10-2-24	12-2-22	222	163	1.36	58.4
X. . . .	10-0-2	11-1-14	152	106	1.43	62.6
Average . .	10-0-23	11-2-11	156	120	1.30	59.74%

In studying the above figures the most obvious point is the comparatively small daily increase in live weight, especially in the control group; in this connection it is interesting to know that during the preliminary period of three weeks stall feeding the increase in live weight was very high, averaging 2.6lbs. and 2.7lbs. per head per day in the animals afterwards composing the two groups.

The supposition that the animals in the beet group would prove better "doers" than the others was borne out by the results, in fact, while the first animal sold was No. IX., of the mangold group (the best

steer of the ten) the next four were all pulp fed. The fifth bullock of the pulp group was a large, coarse-boned animal, which matured slowly, though showing a live weight gain per day slightly above the average. The difference in the live weight increase per day in favour of the pulp-fed group *shows that the food is quite satisfactory*, but the slightly superior quality of the animals in this group must be kept in mind. *All the animals killed well, giving meat of excellent quality*, and the percentage of carcase is well up to the average for this class of bullock—the slight difference in carcase percentage in favour of the control group is so small as to be negligible.

CONCLUSIONS.

(1.) That dried sugar beet slices, when soaked in water and mixed with chaff, form a sound and useful food for fattening cattle.

(2.) That when mixed with chaff of inferior quality and flavour, the addition of a small amount of sugar food or treacle improves the palatability of the mixture, so that the animals clean it up readily.

(3.) That, with animals tied up in stalls, it was not found advisable to give more than 7lbs. pulp per day, the animals eating 7lbs. slices and 8lbs. mangolds, plus chaff, more readily than 8lbs. slices plus chaff without the mangolds.

(4.) That 1lb. pulp fed as above may be looked on as the equivalent of 8lbs. mangolds.

JAMES MACKINTOSH.

3. THE HARPER-ADAMS AGRICULTURAL COLLEGE, NEWPORT, SALOP.

FEEDING EXPERIMENTS.

COMPARATIVE VALUE OF MANGOLDS AND DRIED BEET SLICES.

A comparison of these two fodders was made at the request of the National Sugar-Beet Association, which supplied a quantity of dried beet slices imported from Germany for the purpose.

The analysis of the slices used was as follows:—

Oil	..	..	..	..	..	1.21
Albuminoids	..	..	..	..	..	10.50
Carbohydrates	..	..	..	..	..	60.50
Fibre	..	..	..	..	..	15.90
Ash	..	..	..	..	..	3.60
Moisture	..	..	..	..	..	8.29

100.00

The mangolds used for the trial were Sutton's "Yellow Globe," with the following analysis:—

Dry matter	..	..	..	..	10.90%
Sugar	..	..	..	..	6.80%

The ration per head per day consisted of:—

8 lbs. cake and corn.

8 lbs. straw chop.

Roots (mangolds or beet slices).

The dried beet slices were soaked with water for 24 hours before being fed; the average amount of water used was 45 lbs. to each 12 lbs. of dried slices, the quantity given per head per day.

Eight home-bred two-year-old Shorthorn bullocks were put up for feeding on November 11th, 1911, being divided into four pens of two bullocks each. The animals were weighed at intervals.

On January 16th, 1912, the animals in two of the pens were given beet slices in place of mangolds, and the ration continued until the end of the experiment.

The final result at the end of eight weeks was as follows:—

			Beet Slices.	Mangolds.
Average total gain per head	..	..	3 qrs. 21 lbs.	3 qrs. 13 lbs.

This equals 1 lb. per head per week gained by the animals fed on beet slices *over the animals* fed on mangolds. In other words, the average gain per head per day for the period of experiment was:—

Beet Slices.	Mangolds.
1.88 lbs.	1.74 lbs.

The proportion works out about one to eight, both sets receiving all they required.

The weights of the four beasts at the beginning and end of the trial were:—

				c.	q.	lb.
MANGOLDS	..	..	..	37	2	18
				34	0	22
Difference	..	..	..	3	1	24
BEET SLICES	..	..	..	40	3	14
				37	0	15
Difference	..	..	..	3	2	27

There was slight relaxing at first, apparently caused through the slices, but nothing of any importance.

The animals handled well, but very little difference was noticed between the two lots.

The slices are *undoubtedly a very useful food*, particularly as they are so convenient for storing.

All, of course, depends upon the price at which these slices can be purchased.

P. HEDWORTH FOULKES.

EXPERIMENTS ON MILCH COWS.

The objects in view were:—

- (1.) To compare the milk yield from cows fed on slices with that from cows fed on "roots."
- (2.) To compare the cream yield from cows fed on slices with that from cows fed on "roots."
- (3.) To compare the quality of the butter produced.
- (4.) To watch the general health of the cows fed on slices

THE SOUTH-EASTERN AGRICULTURAL COLLEGE

WITH MILKING COWS.

PLAN OF THE EXPERIMENT.

Owing to the great individual variation in the yield and quality of the milk given by cows, it was not considered advisable to have two groups of animals, as in the case of the steers, but rather to restrict the experiment to two feeding periods with one group—a first period of five weeks on a mangold ration, and a second period of five weeks on a slices ration.

The cows were Shorthorns and Lincoln Reds which calved in January and February; the milk was weighed daily and samples taken morning and evening, and the percentage of butter-fat determined once a week. The cows were weighed at the beginning and end of each period.

The "Steffen" sugar slices used for this experiment were calculated to have a starch equivalent of 70, and as that of mangolds is 7, the slices were fed in the proportion of 1lb. to 10lbs. of mangolds.

THE RATIONS AND METHOD OF FEEDING.

The following ration was fed during the first or mangold period—March 3rd to April 6th.

Bulky Mixture.

- *60lbs. mangolds.
- 15lbs. hay and straw chaff.
- 14lbs. dried grains.
- 14lbs. molascuit.
- 4lb. treacle.
- 2 to 3lbs. hay (long).

All mixed together and fed to all cows four times a day.

* At times sugar beets were mixed with the mangolds—one part beets to two of mangolds.

Concentrated Foods.

- 12lbs. special Mixture to two cows (S. 32, 33).
- 7lbs. " " " " (L. 36, 40).

The above special mixture consisted of $4\frac{1}{2}$ parts dried grains, 2 parts decorticated cotton cake, 2 parts bran, 2 parts cake and molascuit,

with 1 part each linseed cake, Egyptian cotton cake and crushed oats, and was usually fed in proportion to milk yield, but remained unchanged during the experiment.

After April 6th a quantity of the slices was soaked in water and offered to all the cows in the cowhouse; all ate them at once with the exception of two, and these two seemed to have acquired the taste for them by the next day, when the twenty cows readily ate up the quantity offered to them.

The four cows selected for the experiment were then given 4lbs. each per day, and their allowance of mangolds reduced to 20lbs. each; the quantity of slices was increased by 2lbs. at a time until by the 28th April 10lbs. per head per day were given; this amount contained more nutritive matter than the 60lbs. of mangolds fed in the first period, but the increased quantity was given with a view to finding out if scouring, or any undue looseness would follow the use of as much as 10lbs. per head per day. In no case did this occur, and throughout the period the cows were in excellent health and cleaned out their troughs in a most satisfactory manner.

The slices were soaked in water, absorbing twice their own weight, and were mixed with the chaff, etc., next morning.

The cows were tied up in the cowhouse all night, and turned into a covered yard for exercise and water daily from 10 a.m. to 3 p.m.

RESULTS.

Mangold Period—Five weeks. March 3rd to April 12th. Yield and quality of milk from each cow (see Table I., page 45).

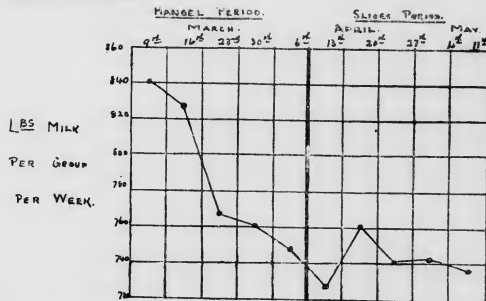
Slices Period—Five weeks. April 7th to May 17th. Yield and quality of milk from each cow (see Table II., p. 45).

QUANTITY OF MILK.

The figures show a gradual decrease in the yield of milk from all the cows during the first five weeks, and, except in the case of S. 33, an increase during the second five weeks. It is most likely that had there been no change in the feeding the tendency to decrease noticeable in the first period would have continued during the second, and, therefore, the increase noted must be attributed to the food.

The following curve shows the gradual fall and subsequent rise due to the change of food.

DIAGRAM OF CURVE.



The second period of the experiment coincided with the growth of grass in the fields, but the cows of the group kept indoors and getting no green food showed as large increases as those going out daily and having the advantage of the spring grass.

The decline in the average yield per cow per day from period I. to period II. is very slight—from 28.24 lbs. per day to 27.10 lbs.—and is less than would be expected over two five-week periods with cows twelve to sixteen weeks after calving.

QUALITY OF MILK.

As regards quality the figures show a decrease in the case of S. 32 of .06 per cent., and increases of .05 per cent. and .26 per cent. in L. 36 and L. 40 respectively, while the average of S. 33 is the same for each period. The average increase over the whole group is only .05 per cent., and this is too slight to enable one to draw conclusions of any kind.

FLAVOUR OF MILK AND BUTTER.

The milk showed no uncommon flavour of any kind while the slices were being fed, and the butter made from the cream after separating was exactly comparable with that made during the mangold period, i.e., typical of the pale-coloured, somewhat hard butter obtained when the cows are fed entirely indoors.

LIVE WEIGHT OF COWS.

		S 32	Inc. or Dec.	S 33.	Inc. or Dec.	L 36.	Inc. or Dec.	L. 40.	Inc. or Dec.
March	..	c. q. lbs. 11 0 25		c. q. lbs. 10 1 20		c. q. lbs. 8 2 23		c. q. lbs. 9 0 0	
April	..	10 3 4	—49	10 0 26	—22	8 2 14	—9	8 0 21	—91
May	..	9 3 20	—96	10 0 0	—26	8 1 0	—42	8 2 22	+57

The above figures show an all-round decrease during the ten weeks of the experiment, with the exception of L. 40. This loss was most pronounced during the slices period, in the case of the two cows S. 32 and L. 36, while with L. 40 the same feeding gave an increase. The complete ration fed during both periods could not be called a light one by any means, and an increase in weight might reasonably have been expected, but in this connection one must keep in mind the great variation in the live weight of cattle which will occur under the same conditions from day to day—out of twenty-six cows weighed by the writer at the same time on three successive days, nineteen showed variations from 12 to 40 lbs.

OTHER EFFECTS.

The experiment extended over too short a time to enable one to come to any conclusions regarding the effects of the food on the breeding powers of the cows, but this point should be kept in mind in considering the general utility of sugar foods. In the above case S. 32 was served on April 30th, but none of the others have as yet (June 1st) come in season.

CONCLUSIONS.

(1) That the "Steffen" Sugar Slices when soaked in water and mixed with chaff, etc., form an appetising food for milking cows—more appetising than chaff, etc., and mangolds.

(2) That 8 to 10 lbs per head per day may be given to cows of 9 to 11 cwt. without any notable laxative effect.

(3) That 10 lbs. per head per day had no effect in increasing or decreasing the percentage of butter-fat in the milk, or on the colour and flavour of the butter produced.

JAMES MACKINTOSH.

MANGOLDS PERIOD.—TABLE I.

Date.	S 32.			S 33.			L 36.			L 40.					
	Fat percentage.	Total Milk.	Average.	Fat percentage.	Total Milk.	Average.	Fat percentage.	Total Milk.	Average.	Fat percentage.	Total Milk.	Average.			
March 9	2.7	3.8	3.08	2.8	4.1	3.50	276	3.4	3.8	3.57	139	2.6	3.7	3.23	168
" 16	3.4	3.9	3.60	2.8	3.7	3.15	282	3.8	3.9	3.85	142	2.3	3.7	2.88	155
" 23	2.9	4.0	3.35	2.4	4.2	3.21	250	3.2	3.9	3.33	136	2.6	3.9	3.15	143
" 30	3.0	4.1	3.47	2.3	4.0	3.23	263	3.3	3.6	3.41	127	2.7	4.0	3.25	136
April 6	2.9	4.0	3.33	2.3	3.9	3.14	250	3.3	3.9	3.55	130	2.75	3.8	3.18	137
Average	3.36	3.24	3.45	2.64	3.25	3.25	264	3.55	135	3.08	148				
Average per day.	34.50	37.74	34.50	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74			

Average per day for the four cows: Milk 28.24 lbs.; Butter-fat 3.30 per cent.

SICES PERIOD.—TABLE II.

Date.	S 32.		Total Milk.	S 33.		Total Milk.	L 36.		Total Milk.	L 40.		Total Milk.		
	Fat percentage. Morn. Even. Aver.	Fat percentage. Morn. Even. Aver.		Fat percentage. Morn. Even. Aver.	Fat percentage. Morn. Even. Aver.		Fat percentage. Morn. Even. Aver.	Fat percentage. Morn. Even. Aver.						
April 11	2.7	4.1	3.30	2.5	4.0	3.21	3.4	3.7	3.51	3.2	4.2	3.59	132	
" 20	3.0	4.4	3.59	2.7	4.25	3.46	243	3.1	3.9	3.45	3.6	3.75	3.06	138
" 27	2.9	4.2	3.44	2.4	4.3	3.63	238	3.2	4.1	3.61	3.4	3.6	2.89	146
May 4	2.4	3.9	3.00	2.1	4.0	3.10	228	3.5	4.4	3.88	3.8	3.53	150	146
" 11	2.9	3.6	3.11	2.3	4.0	2.85	240	2.9	4.0	3.59	3.0	3.7	3.31	147
Average	3.30	3.30	3.38	3.25	3.25	3.25	236	3.60	139	3.34	142	3.34	142	
Average per day	34.37	33.68	34.37	33.68	33.68	33.68	33.68	33.68	33.68	33.68	33.68	33.68	33.68	

Average per day for the four cows: Milk 27.10 lbs.; Butter-fat 3.35 per cent.

THE UNIVERSITY COLLEGE, READING.

REPORT OF EXPERIMENTS

Carried out for Mr. R. N. DOWLING, at UNIVERSITY COLLEGE,
READING,

TO COMPARE THE COMPARATIVE FEEDING VALUE OF MANGOLDS
AND THEIR EQUIVALENT OF SUGAR-BEET SLICES.—6/6/12.

Four cows were selected all of which had calved the previous autumn, three of them heifers and one cow with her second calf; these were divided into couples so that the milk yield of each couple was as nearly equal as possible. The cows were all fed on slices for a week before the beginning of the experiment to accustom them to the diet. Then each couple was fed for a period of 14 days on a ration containing either mangolds or sugar-beet slices, but only the milk yield of the second week was taken into account when contrasting the two diets, thus the diet of the one 14 days could have no effect on the milk yield or fat percentage of the other, also the alternating of the cows from the mangold to the beet slice ration reduced to a minimum any error that might arise from the idiosyncrasy of any cow relating to the rise or fall in yield or quality from natural circumstances.

The ration was as follows:—

Mangolds	50lbs.	or sugar beet slices	8lbs.
Hay	.. .. .	.. .. .	14lbs.
Oat straw	.. .. .	.. .. .	7lbs.
Decorticated cotton cake	.. .. .	.. .. .	2lbs.
Linseed cake	.. .. .	.. .. .	1lb.
Indian meal	.. .. .	.. .. .	2lbs.
Malt gluten meal	.. .. .	.. .. .	1lb.

The experiment was continued for a period of eight weeks; the milk of each cow was weighed morning and evening, and the fat percentage taken on alternate days both morning and evening by Gerber's test.

COMPARATIVE TEST OF FEEDING DAIRY CATTLE
WITH MANGOLDS OR THEIR EQUIVALENT
OF SUGAR-BEET SLICES.

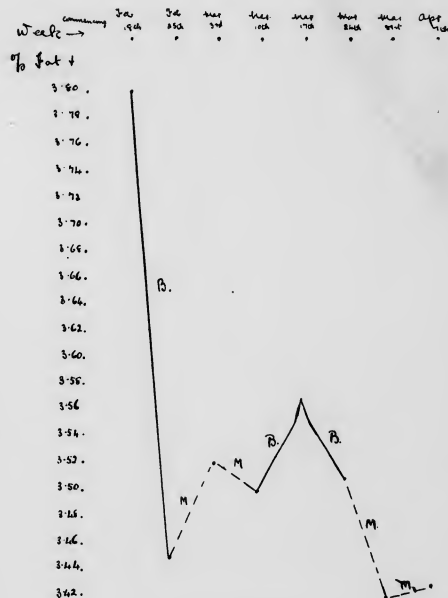
TABLE OF MILK YIELDS AND AVERAGE FAT PERCENTAGES.

Date.	Sugar Beet Slices.			Mangolds.		
	Cows.	Milk yield in lbs.	Average Fat per centage.	Cows.	Milk yield in lbs.	Average Fat per centage.
Feb. 18th to 24th	 A & B	365	3.8	C & D	306	3.42
Feb. 25th to Mar. 2nd	 "	370	3.45	 "	391	3.58
Mar. 3rd to 9th	 C & D	377	3.62	A & B	368	3.52
Mar. 10th to 16th	 "	375	3.45	 "	384	3.5
Mar. 17th to 23rd	 A & B	360	3.57	C & D	363	3.57
Mar. 24th to 30th	 "	382	3.51	 "	371	3.55
Mar. 31st to April 6th	 C & D	378	3.42	A & B	393	3.42
April 7th to 13th	 "	393	3.52	 "	380	3.43
Totals	.. ..	1520	3.48	1526	3.51	
		lbs.	% fat.	lbs.	% fat.	

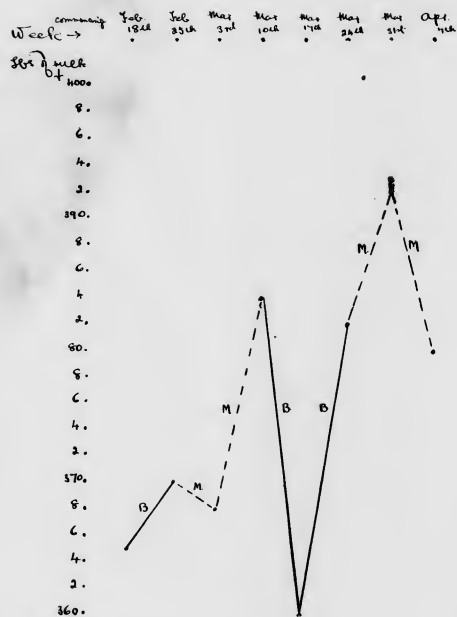
In this table only the second week of feeding on sugar-beet or on mangolds has been taken into account (i.e., the figures in black) so that

the influence of the food in each case was at work for a week before any figures were considered.

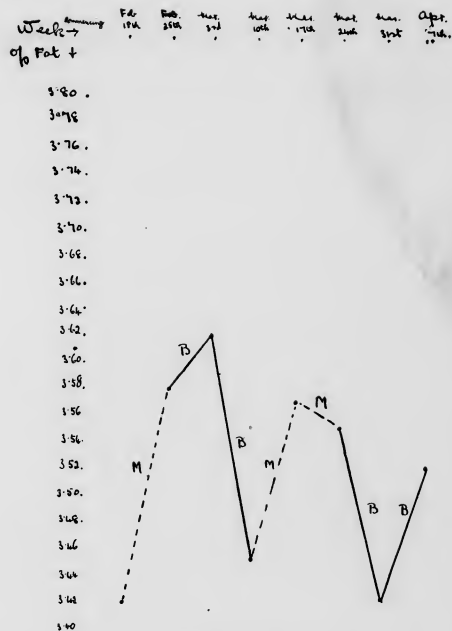
N.B.—Mr. R. Hart-Synnot wishes me to say that he was unable to use more cows and that he cannot draw any conclusions from this small number.—R.N.D.



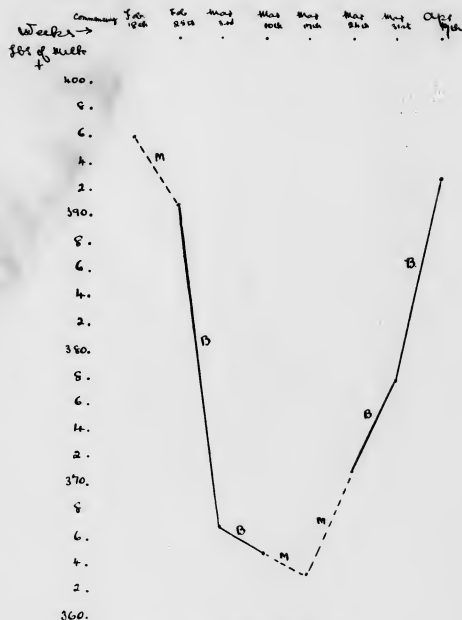
Cows A & B % fat.



Cows A & B Milk yield in lbs.



Cows C & D % fat.



Cows C & D Milk yield in lbs.

THE ROYAL AGRICULTURAL COLLEGE.

EXPERIMENT WITH FEEDING SUGAR-BEET SLICES
(SCHNITZEL) TO MILCH COWS.

This experiment was carried out with the object of testing the value of sugar-beet slices as a substitute for roots in a ration for milch cows, mangolds being used for the purpose of comparison.

Six cows were selected from the College herd, and divided into two lots of three each, the choice being made so as to equalise, as nearly as possible, the age, period of lactation, and daily yield of milk of the cows in each section. The trial was conducted over a period of three weeks, and terminated on January 30th.

The rations fed during the experiment were as follows, viz:—

LOT A. (MANGOLDS).

Pulped mangolds, 35 lbs.; straw chaff, 8 lbs.; hay, 9 lbs.; Bombay cotton cake, $1\frac{1}{2}$ lbs.; Soya cake, $1\frac{1}{2}$ lbs.; Gram, 1 lb.; Molascuit, 2 lbs.

LOT B. (SUGAR BEET SLICES).

Sugar-beet slices (dry), $4\frac{1}{2}$ lbs.; straw chaff, 8 lbs.; hay, 9 lbs.; Bombay cotton cake, $1\frac{1}{2}$ lbs.; Soya cake, $1\frac{1}{2}$ lbs.; Gram, 1 lb.; Molascuit, 2 lbs.

Up to January 8th both lots of cows were fed on a ration containing mangolds, as with lot A above. On January 9th the dried sugar-beet slices were gradually introduced into the rations of lot B; and by January 14th the mangolds were discontinued, their place being entirely taken by the dried slices.

The dried slices were soaked for some twenty-four hours before being fed to the cows, warm water being used for the purpose.

The milk of each lot was carefully weighed night and morning, and tested for the percentage of butter fat and cream, the weekly averages being as follows, viz:

LOT A. (FED ON MANGOLDS)

Week ending		A.M. Milk in lbs.	Percentage of fat.	Percentage of cream.	P.M. Milk in lbs.	Percentage of fat.	Percentage of cream.
Jan. 16	..	227	3.01	10.78	140	4.30	14.71
" 23	..	229 $\frac{1}{2}$	3.30	11.50	137 $\frac{1}{2}$	4.27	15.28
" 30	..	231	3.30	11.43	137 $\frac{1}{2}$	4.05	14.21

LOT B. (FED ON SUGAR-BEET SLICES).

Week ending		A.M. Milk in lbs.	Percentage of fat.	Percentage of cream.	P.M. Milk in lbs.	Percentage of fat.	Percentage of cream.
Jan. 16	..	286	2.97	10.28	160 $\frac{1}{2}$	4.04	15.64
" 23	..	257	3.17	11.35	171	3.91	15.50
" 30	..	250	3.21	10.43	176	3.93	14.30

SEPARATION OF CREAM.

Each lot of milk was separated at the same temperature (100° F.), the cream being afterwards scalded at 150° F., and then cooled to 60°. A "starter" was then added at the rate of half-a-pint per gallon of cream.

It was decided to churn three times a week for the purpose of observing the effect of each food on the butter produced.

It may be mentioned that the times of milking on the College Steading are 6 a.m. and 3 p.m., respectively, and the long interval would account for the low percentage of butter fat in the morning's milk.

The cream of only two cows in each lot was reserved for churning, and the details of the temperature, time of churning and butter produced are set out in the following table:—

LOT A. (FED ON MANGOLDS).

Week ending	Temp. of churn. Fahr.	Temp. of cream. Fahr.	Time in churning.	Lbs. of butter made. lbs. ozs.	Ratio of butter to milk.
Jan. 16	62° F.	59° F.	12 min.	10 13	1:26.68
" 23	61°	60°	21 "	10 8	1:25.85
" 30	62°	60°	25 "	10 5	1:26.15

LOT B. (FED ON SUGAR-BEET SLICES).

Week ending	Temp. of churn. Fahr.	Temp. of cream. Fahr.	Time in churning.	Lbs. of butter made. lbs. ozs.	Ratio of butter to milk.
Jan. 16	62° F.	59° F.	15 min.	9 3	1:26.99
" 23	61°	62°	26 "	9 0	1:26.50
" 30	62°	63°	17½ "	9 6	1:25.49

To start with, both lots of cream were churned at exactly the same temperature (59° F.), but this had to be altered subsequently to suit the conditions of the butter from each lot. Owing to the sharp frost which set in just after the commencement of the experiment, it was found necessary to raise the temperature of churning to 60° in lot A, and 63° in lot B.

As regards texture, the butter from the cream of Lot B. (fed on slices) was much firmer and more brittle than that from Lot A.

With reference to the ratio of butter to milk, very little variation was to be noticed in either lot during the course of the experiment.

CONCLUSIONS.

The general conclusions which may be drawn from this trial are as follows:—

(1.) As regards the effect of the two rations on the quantity of milk produced it is to be noticed that the yield of lot A remained constant, while in the case of lot B there was a slight fall in yield during the period of the experiment.

(2.) The quality of the milk seemed to be little affected by the change of food, as shown by the percentage of butter-fat in the above tables. A slight increase, if anything, was noticed in the morning's milk in each case, and a corresponding decrease in the quality of the evening's milk.

(3.) The butter produced from the cream of lot A was normal in texture, and yielded well, as shown by the butter ratio above; but it was very pale in colour. The butter from the milk of lot B, on the other hand, was hard and more difficult to work, and had to be churned at a higher temperature in consequence; the colour, however, was much better than that from lot A.

(4.) Referring to the general health of the cows during the trial, the dried slices at first seemed to have a laxative effect till the animals settled to their feed. It was also to be noticed that the cows in lot B showed greater signs of thirst and drank more water than those being fed on mangolds.

Further, the cows in lot B did not take readily to the dried slices, and seemed to lose their flesh and bloom more rapidly than those in lot A.

From the above observations it appears evident that the value of dried slices as a substitute for roots would depend on the price at which they could be obtained per ton in this country.

DRYSDALE TURNER,

CHARLES D. STEWART.

GENERAL CONCLUSIONS.

The results conclusively show that the residual sugar-beet slices, which are returned to the farmer after the sugar has been extracted, form a really useful and sound food.

In comparing the "money value" or "purchase price" of these slices with the value of mangolds it must be remembered that this is only part of the transaction, and that the grower would have received cash for beets sold, and that it is not proposed to grow sugar-beet to get beet slices to feed, but to get a quick gross return; and it is, therefore, invaluable to know that the "by-product" has such good feeding properties for fattening cattle and milch cows.

The results are summed up by Professor T. B. Wood, when he states that "prospective users of slices may take it that slices are good food for fattening cattle as a substitute for roots, and that 14 lbs. of 'ordinary' dried slices are equal to 112 lbs. of ordinary mangolds, and rather better than 112 lbs. of swedes—that is, a proportion of 1 lb. of slices to 8 lbs. of mangolds."

This conclusion is endorsed by the other institutions both for fattening cattle and milch cows.

R. N. D.

COMPARISON OF MANGOLDS WITH SUGAR-BEET.

In view of the fact that many farmers who are growing sugar-beet trials will be obliged to consume the roots on the farm until a factory is established in their neighbourhood, it was thought advisable to get more definite information on the comparative feeding value of mangolds and sugar-beet.

Principal Hedworth Foulkes kindly undertook this trial, and has issued the following report:—

COMPARISON OF MANGOLDS WITH SUGAR-BEET.

A trial was made in order to ascertain the comparative feeding value of mangolds and sugar-beet.

A similar quantity of concentrated food was allowed in each case, namely :—

7 lbs. cake and corn per head per day.
8 lbs. straw chop per head per day.

Four home-bred bullocks under equal conditions were fed in two pens side by side in the same way, except as regards roots.

The total gain per head for the 28 days worked out as follows :—

	Beet-fed Bullocks.		Mangold-fed Bullocks.
	57 lbs.	..	48 lbs.
Equal to a daily gain per head ..	2.04 lbs.	..	1.7 lbs.

The animals were given a full allowance of roots, *i.e.*, as much as they would consume, and it was found that the mangold-fed bullocks consumed 75 lbs. per head per day, and the beet-fed bullocks were satisfied with 57 lbs. per head per day.

The final conclusion drawn from this trial is that 1 lb. increase per head live weight is produced from the consumption of :—

7 lbs. cake and corn,
8 lbs. straw chop,

and either 44.1 lbs. mangolds or 27.9 lbs. sugar beet.

P. HEDWORTH FOULKES,

Principal Harper-Adams Agricultural College, Salop.



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